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Revision of the tropical African genus *Tetraconcha* (Orthoptera: Tettigoniidae: Phaneropterinae) with the description of ten new species

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Abstract

Only five species of the genus *Tetraconcha* Karsch, 1890 have been previously known; they inhabit tropical forests of central and western Africa. Generally, specimens belonging to this genus are scarcely represented in museum collections, probably due to the difficulty in finding them, but also for the fragility of their body and legs. During some recent expeditions in the Central African Republic and Ivory Coast it was possible to put together an abundant amount of specimens. This allowed the present author to revise the genus and to find valid characters to distinguish different species. On the whole, ten new species were discovered and the total number now amounts to fifteen species. Interestingly, in the Dzanga-N'Doki National Park (Central African Republic) seven sister species, previously unknown, live together with *T. smaragdina*; it was possible to separate them by the shape and number of teeth of the stridulatory file under the left tegmen, and later other taxonomical characters were provided. This may be considered a case of evolutionary radiation; that is, *Tetraconcha* species in the Dzanga-N'Doki National Park evolved traits that primarily linked to sound communication. This radiation very probably occurred randomly, possibly driven by genetic drift.

Key words

distribution, evolutionary radiation, stridulatory file, taxonomy

Introduction

According to Ragge (1962), the genera *Drepanophyllum* Karsch, 1890, *Stenamblyphyllum* Karsch, 1896, *Debrona* Walker, 1870, and *Tetraconcha* Karsch, 1890 are a fairly well-defined group of African Phaneropterinae, in which the fore tibiae are biconchate and the fastigium of the vertex has a steeply sloping or vertical sulcus. Females have a greatly reduced ovipositor, crenulate at the tip. Actually the tribe Otiaphysini Karsch, 1889 contains only the genera *Tetraconcha* and *Debrona*, while *Drepanophyllum* is the only species of the Karschiae group, and *Stenamblyphyllum* is not listed in any tribe or group of Phaneropterinae (Cigliano et al. 2017). The genus *Tetraconcha* was described by Karsch (1890a) for the species *T. fenestrata*; in the same year Karsch (1890b) described another species, *T. stichyrata*. The following year, Brunner von Wattenwyl (1891) described *T. smaragdina* and *T. scalaris*: the latter was synonymized with *T. stichyrata* by Kirby (1906). *T. stichyrata* was indeed overlooked by Brunner von Wattenwyl (1891). Due to the remarkable sexual dimorphism, Bolívar (1893) erected the new genus *Tellidia* for the female of another new species (*longipes*), which Bolívar (1906) later synonymized with *Tetraconcha*.

The availability of a long series of specimens procured in 2005–2012 by Philippe Annoyer and Philippe Moretto from the Central African Republic provided the possibility to divide them into seven taxonomic units, vaguely similar to *T. smaragdina*. Specimens were collected during the night, attracted to a lamp in the same site and dates within the tropical forest of the Dzanga-N'Doki National Park. During a visit to the Naturhistorisches Museum of Vienna the type of *T. smaragdina*, considered probably lost (Cigliano et al. 2017), was re-discovered. This allowed the author to identify some of the specimens collected in the Central African Republic as belonging to *T. smaragdina* and to note that the other specimens belonged to undescribed species. Additionally, a series of other specimens of *Tetraconcha* collected by Marios Aristophanous, Philippe Moretto and Enrico Ruzzier for the British Museum of Natural History in the Ivory Coast in 2014–2015 was obtained on loan; this material provided another two undescribed species. Finally, during an expedition in the Taï National Park (Ivory Coast) in 2017, further specimens were collected by P. Annoyer, S. Danflous, P. Moretto and the present author: among this material another undescribed species was discovered. The high diversity of the genus, previously unrecorded, deserves particular attention. This paper deals with the known species as well as a number of new species and attempts to place them within their evolutionary context.

Material and methods

Series of specimens were obtained from Marios Aristophanous, Philippe Annoyer, Samuel Danflous, Philippe Moretto, Enrico Ruzzier and the present author; further specimens were examined from collections housed in the museums cited below.

Abbreviations used in this paper.—

BMPC Bruno Massa Collection, Palermo;
MfN Museum für Naturkunde, Berlin;
MNCN Museo Nacional de Ciencias Naturales, Madrid;
MRT Museo Regionale di Storia Naturale, Terrasini (Palermo);
MSNG Museo Civico di Storia Naturale 'G.Doria', Genoa;
MSNM Museo Civico di Storia Naturale, Milan;
MZUF Museo di Zoologia dell'Università "La Specola", Florence;
NHM Natural History Museum, London;
NMW Naturhistorisches Museum Vienna;
PACT Philippe Annoyer Collection, Toulouse;
RBINS Royal Belgian Institute Natural Sciences, Bruxelles;
RMCA Royal Museum for Central Africa, Tervuren.

Some specimens were photographed with a Nikon Coolpix 4500 digital camera, mounted on a Wild M5 Stereomicroscope or Leica MZ75, and photos were integrated using the freeware CombineZP (Hadley 2008). Mounted specimens were measured with a digital calliper (precision 0.01 mm); the following measurements were taken (in mm): Body length: dorsal length from the head to the apex of the abdomen, ovipositor excluded in females; Hind femur: length of hind femur; Tegmina: length and maximum width of tegmina; Ovipositor: maximum length, subgenital plate included.

According to Ragge (1980) the shape of the stridulatory file under the male's left forewing and the number and arrangement of the teeth are often useful at the species level (see also Heller 2006). Therefore the stridulatory file of each species was photographed and described. In addition, because some differences were noticed on the size of cubital areas between the cubital veins of the left tegmen, the distance from the base of the tegmen to the maximum width of the lower cubital area and the width of the two cubital areas at that distance were measured (Table 1; see also Figs 32, 57).

Results and discussion

Tribe Otiaphysini Karsch, 1889

Type genus.—*Otiaphysa* Karsch, 1889 (= *Debrona* Walker, 1870).

Material examined (other than *Tetraconcha*).—*Stenamblyphyllum dilutum* Karsch, 1896: Cameroon, Victoria (lectotype ♀) (MfN); Cameroon (1♀) (MCNM); Central African Republic, Dzanga-N'Doki National Park, Sangha 15.X.2008, P. Annoyer (1♂); Central African Republic, Dzanga-N'Doki National Park, Lac 1, 19.II.2012, 25.II.2012 (UV trap), P. Annoyer (2♂) (PACT); Central African Republic, Dzanga-N'Doki National Park, 29.II-1.III.2012 (UV trap) P. Moretto (1♂) (BMPC); *Drepanophyllum marmoratum* Karsch, 1890: Central African Republic, Dzanga-N'Doki National Park, N'Doki 25.I.2012, P. Moretto (1♂); N'Doki 24–25.II.2012 (UV trap), P. Moretto (1♀); N'Doki 14–15.II.2012 (UV trap), P. Moretto (1♀) (BMPC); Dzanga-N'Doki National Park, Lac 1, 19.II.2012, 25.II.2012 (UV trap), P. Annoyer (2♂, 1♀) (PACT); Gabon (1♂) (MNCN); *Drepanophyllum corrosifolium* Karsch, 1896: Equatorial Guinea, Fernando Poo, Musola I.1902, L. Fea (1♂) (MSNG); *Debrona hebetata* Karsch, 1889 (considered synonym of *Debrona cervina* Walker, 1870): Tanzania, Usambara II-III.1886 (holotype ♀) (MfN); *Debrona cervina* Walker, 1870: Democratic Republic of Congo, Nguela 1899 (1♂); Tanzania, Dar El Salaam (1♂); Tanzania, Makond. Hochld. 8–11.XII.1910, H. Grote (1♂) (MfN); Kenya, Arabuko Sokoke forest 8–24.VI.1998, L. Bartolozzi and A. Sforzi (2♂, 1♀) (MZUF).

According to Karsch (1890a), Othiaphysini (including *Debrona* and *Tetraconcha*) are characterised by undulate veinlets on the tegmina, fore tibiae with both conchate tympana, armed fore and mid femora, and short ovipositors as in Ephippithytae with crenulate upper margins. Following Ragge (1962), the genera *Debrona* (Figs 1–7, 78, 87), *Drepanophyllum* (Figs 8, 76, 86), *Tetraconcha* (Figs 9, 11–66, 67–75, 79–85, 88–99) and *Stenamblyphyllum* (Figs 10, 77), form a fairly well-defined group. In this genus group the fore tibiae are biconchate, the fastigium of the vertex has a steeply sloping or vertical sulcus, and the females have a greatly reduced ovipositor, crenulate at the tip (Figs 7–10). Only in *Stenamblyphyllum* the venation of tegmina is fairly normal in both sexes and the fastigium of the vertex has not undergone the extreme modification shown by the other three genera. The males of *Stenamblyphyllum* show a slight stridulatory modification near the base of the anterior median vein and the fastigium of the vertex has a vertical sulcus. Another difference is the presence of a fronto-genal carina in *Drepanophyllum*, absent in the other related genera. The ovipositor is very short in *Drepanophyllum* (ca 2.0–2.2 mm), slightly longer in *Tetraconcha* (about 2.5 mm in the few known specimens), while in *Debrona* it is longer (ca 3.0 mm). In *Stenamblyphyllum* the ovipositor (length ca 2.5 mm) is more slender than in all other genera. The males of all these genera do not have styli, but their subgenital plate ends with two more or less long appendices. Nevertheless, *Tetraconcha*, *Debrona*, *Drepanophyllum* and *Stenamblyphyllum* show enough similarities to all be included within the tribe Otiaphysini.

The distribution of the genus *Debrona* covers the eastern and southern areas of Africa, from Tanzania and Kenya to South Africa. *Drepanophyllum* and *Stenamblyphyllum* species occur in central Africa, while *Tetraconcha* is restricted to central and western Africa.

Genus *Tetraconcha* Karsch, 1890

Karsch, 1890a. Entom. Nachricht. 16: 61.

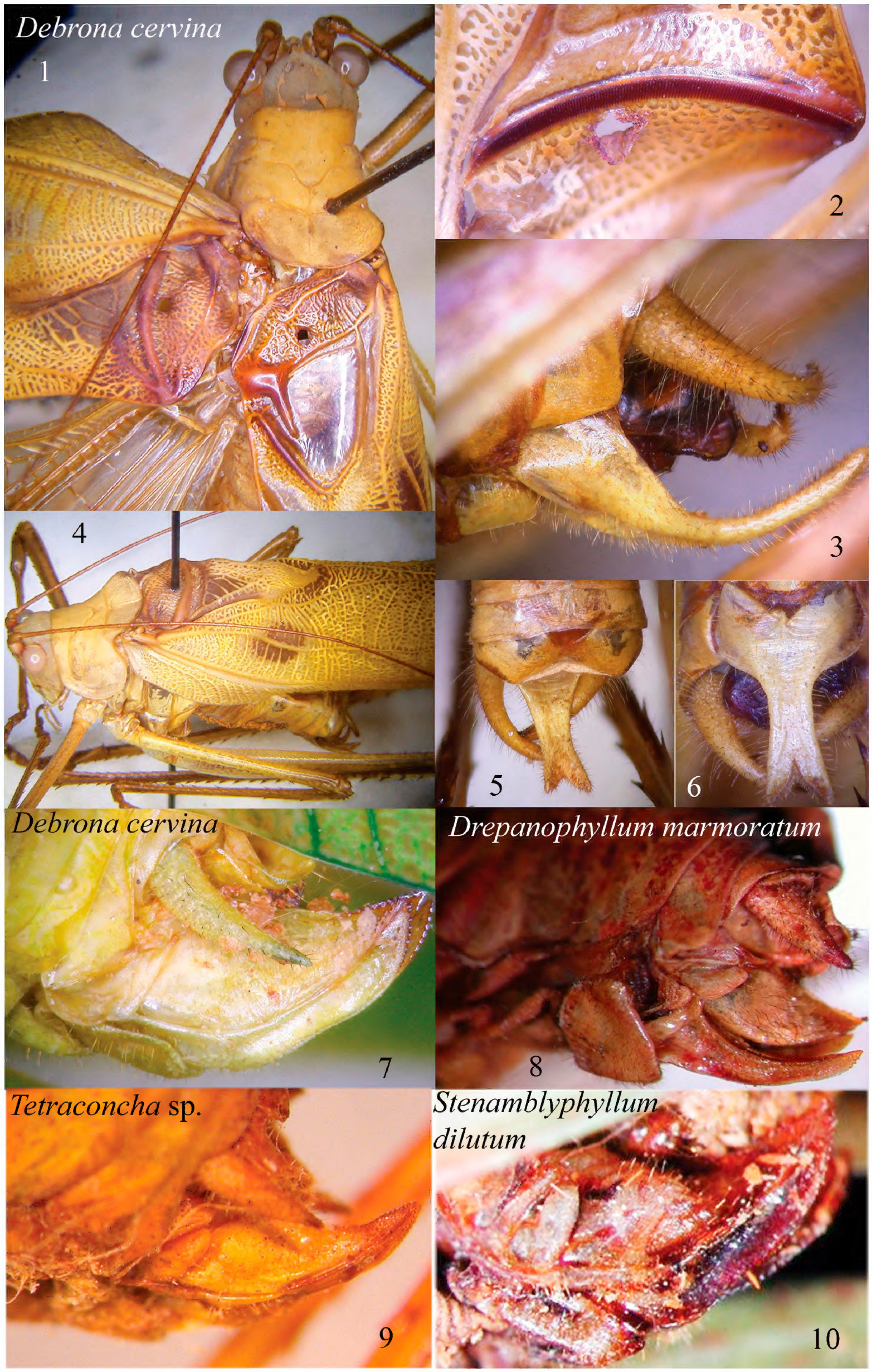
Remarks.—The main characters of the genus are the following (Karsch 1890a; pers. obs.): head small, fastigium of vertex raised, tuberculated, not contiguous with fastigium of frons, sulcate, first antennal segment clearly larger than others. Eyes round, very prominent, antennae very delicate. Pronotum narrow and compressed, flat above, enlarged posteriorly, anterior margin straight, posterior margin rounded, humeral sinus rounded and deep, lateral lobes longer than high, lower margin rounded. Tegmina narrow, exceeding hind femora, anterior margin rounded, posterior margin sinuous, apex obliquely cut. Hind wings longer than tegmina. Legs very fragile and long. Fore femora compressed, lower margin armed, hind femora thin. Both inner and outer tympana of fore tibiae conchate. Cerci of male short incurved and pointed, subgenital plate more or less bilobed or pointed, styli absent. Tegmina and legs are always narrow and give to the species the long-limbed aspect. The name *Tetraconcha* derives from the conchate tympana (from Greek *tetra* = four).

Species account

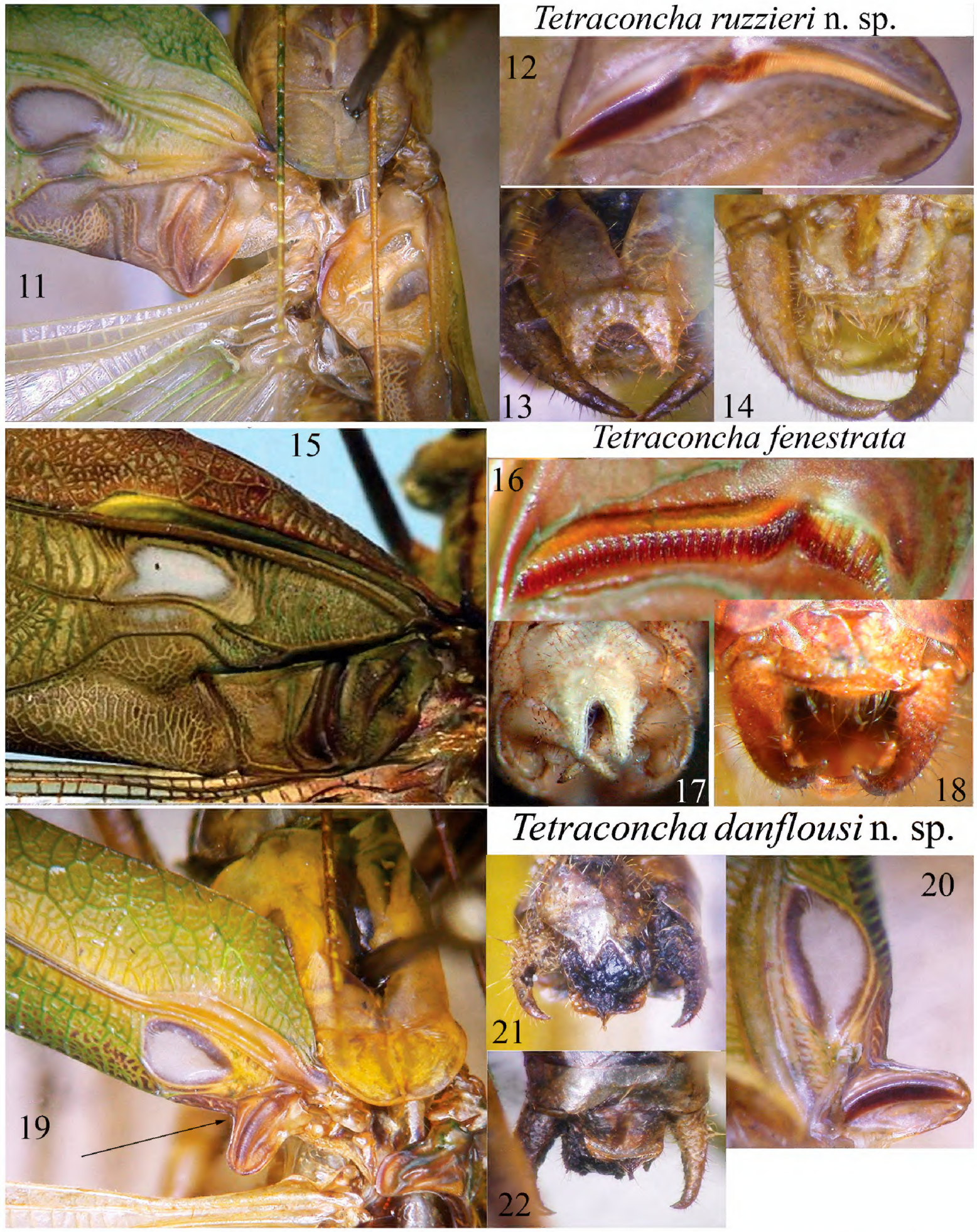
Tetraconcha ruzzieri sp. n.

http://lsid.speciesfile.org/urn:lsid:Orthoptera.speciesfile.org:TaxonName:501041
http://zoobank.org/817F4010-B540-47F3-BCEA-5701EB93FC78
Figs 11–14, 71, 99

Material examined and depository.—Ivory Coast, Aszani N. Park 26.XI–1.XII.2015, 05°14'33.7"N, 04°48'06.2"W (light trap), M.



Figs 1–10. *Debrona cervina* male (Kenya, Arabuko Sokoke Forest): **1.** Stridulatory area; **2.** Stridulatory file below the left tegmen; **3.** Cerci and subgenital plate in lateral view; **4.** Habitus in dorsal view; **5.** Subgenital plate in dorsal view; **6.** Subgenital plate in ventral view. *Debrona cervina* female (same locality): **7.** Ovipositor in lateral view. *Drepanophyllum marmoratum* female (Central African Republic, N'Doki): **8.** Ovipositor in lateral view. *Tetraconcha* sp. (probably *smaragdina*) female (Cameroon, Mukonje Farm): **9.** Ovipositor in lateral view. *Stenamblyphyllum dilutum* lectotype female (Cameroon, Victoria): **10.** Ovipositor in lateral view.



Figs 11–22. *Tetraconcha ruzzieri* sp. n. paratype male (Ivory Coast, Taï Nat. Park): **11.** Stridulatory area; **12.** Stridulatory file below the left tegmen; **13.** Subgenital plate in ventral view; **14.** Cerci in dorsal view. *Tetraconcha fenestrata* holotype male (Cameroon): **15.** Stridulatory area of the left tegmen; **16.** Stridulatory file below the left tegmen. *Tetraconcha fenestrata* male (Cameroon, Mukonje Farm): **17.** Subgenital plate in ventral view; **18.** Cerci in dorsal view. *Tetraconcha danflousi* sp. n. holotype male (Ivory Coast, Taï Nat. Park): **19.** Stridulatory area; **20.** Stridulatory file below the left tegmen and "window" of the left tegmen; **21.** Subgenital plate and cerci in ventral view; **22.** Cerci in dorsal view. Figs 15 and 16 after Orthoptera Species File.

Aristophanous, P. Moretto, E. Ruzzier (♂ holotype); Ivory Coast, Taï Nat. Park, Res. Station 5–10.VII.2015, 05°49'59.8"N, 07°20'32.0"W (light trap), M. Aristophanous, P. Moretto, E. Ruzzier (2♂ paratypes) (NHM); Ivory Coast, Taï Nat. Park, Res. Station 21.III.2017 (night), S. Danflous (1♂ paratype); Ivory Coast, Taï Nat. Park, Res. Station 4.IV.2017 (light trap), P. Moretto (1♂ paratype) (BMPC).

Color.—Head and pronotum yellow-green, abdomen brown, cerci yellow, black at the tip, tegmina green-yellow, brownish in the stridulatory area, with a translucent area. Fore femora brown with 4–6 black spots, mid and hind tibiae brown. One wide black spot is visible laterally on the metanotum, below the hind wing, present only in *T. danflousi* sp. n. This exclusive character excludes that it is the male of *T. longipes*, known only from the female sex, and was also collected from the Ivory Coast, along the coast next to the border with Ghana.

Description.—Males. Head and antennae: Fastigium of vertex narrow, sulcate above, separated from fastigium of frons. Eyes round-

ed, well projecting. Antennae longer than body. Legs: Fore coxae armed with a small spine. Fore tibiae furrowed on dorsal side, distinctly widening above tympanum, conchate on both sides. Fore femora armed on inner ventral side with 10–12 spines, fore tibiae with 4–5 spines + 1 spur on inner side and 3 small spines on anterior ventral side, 4 spines + 1 spur on outer dorsal side, mid femora armed with 5–6 spines on outer ventral side, mid tibiae with 12–13 spines on outer and inner ventral sides + 1 spur on each side, and 7 spines + 1 spur on inner dorsal side, hind femora armed with 3–4 small spines on outer side, hind tibiae with many spines on ventral and dorsal sides + 3 spurs on each side. Thorax: Pronotum narrowing anteriorly, flat above, anterior margin incurved, posterior margin rounded, humeral sinus well developed, lobes of pronotum rounded. Tegmina narrow with rounded apices, with an evident translucent area (window), laterally on the left and on the right of stridulatory areas of the left and right tegmina, respectively. Wings longer than tegmina. Stridulatory area of left and right tegmina shown in Fig. 11, veinlets of left tegmen in Fig. 99; stridulatory file arched and interrupted at the mid by a bulge, the half whitish proximal part composed of ca. 80 very dense and evenly spaced teeth, the central brown part (including also the bulge) composed of ca. 30 widely spaced teeth, and the distal brown part composed of ca. 80–90 dense and evenly spaced teeth (Fig. 12). Abdomen: Subgenital plate with a well-developed concavity, cerci slender, fairly straight and incurved at the tip (Figs 13–14).

Female. Unknown.

Measurements.—Cf. Tables 1 and 2.

Diagnosis.—*T. ruzzieri* sp. n. seems to be related to *T. fenestrata*, but its windows (translucent areas) on the tegmina are differently placed, like all veinlets (compare Figs 69, 71, 99). Different between males of the two species are also the subgenital plates, the stridulatory files and cerci. It is also related to *T. danflousi* sp. n., which has only one small window on the tegmina and a clear concavity between the stridulatory file and the rest of the tegmina.

Etymology.—This species is named after Enrico Ruzzier, who, together with M. Aristophanous and P. Moretto, collected many specimens of Orthoptera in the Ivory Coast by means of light traps in 2015; the material caught was sent on loan to the present author.

Tetraconcha fenestrata Karsch, 1890

http://lsid.speciesfile.org/urn:lsid:Orthoptera.speciesfile.org:TaxonName:8791

Figs 15–18, 69, 81

Karsch, 1890a. Entom. Nachricht. 16: 62.

Type locality.—Cameroon (MfN).

Material examined.—Cameroon (♂ holotype) (MfN); Equatorial Guinea, Fernando Póo, Basile 1901 (1♂); Cameroon, Mukonje Farm, R. Rohde (1♂, 1♀) (MSNG); Equatorial Guinea, Fernando Póo (1♂); Cameroon (1♂) (MNCN); Ivory Coast, Okem (1♂); Cameroon, Mundame (1♂, 1♀) (NMW); Cameroon, Mukonje Farm, R. Rohde (7♀); Cameroon (1♂); Cameroon, Bonamo (1♂) (RBINS).

Remarks.—*T. fenestrata* is the type species of the genus *Tetraconcha*. The ratio length/width tegmina in males is between 3.5 and 3.6, in females it is between 2.6 and 3.4 (Bolívar 1906; present study). Kirby (1906) cited it from Ivory Coast, Bolívar (1906) described the female. Griffini (1906) cited 1♂ from Fernando Póo, and later Griffini (1908) described the female and recorded 3♂ and 8♀ from Cameroon. Sjöstedt (1912) recorded 3♀ from Buea (Cameroon).

The name *fenestrata* refers to the wide translucent area (from Latin *fenestra* = window) on the tegmina. The stridulatory area of left and right tegmina are shown in Fig. 15; stridulatory file arched and interrupted before the proximal end by a bulge, followed by ca. 15 teeth decreasing in size, distal part (including also the bulge) is composed of ca. 35 widely spaced teeth (Fig. 16), subgenital plate with a narrow concavity, cerci stout and incurved at the tip (Figs 17–18).

Distribution.—*T. fenestrata* covers Central and West Africa (it is known from Cameroon, Ivory Coast and Equatorial Guinea).

Tetraconcha danflousi sp. n.

http://lsid.speciesfile.org/urn:lsid:Orthoptera.speciesfile.org:TaxonName:501042

http://zoobank.org/143B50AD-6D6C-4203-8C2B-FCA2474C0942

Figs 19–22, 75, 97

Material examined and depository.—Ivory Coast, Taï Nat. Park, Res. Station 11.III.2017 (light), B. Massa (1♂ holotype) (BMPC).

Table 1. Morphometric characters characterizing the stridulatory area of the species of the genus *Tetraconcha*.

Species	Length of stridulatory file (mm)	Distance between left tegmen base and max width of lower cubital area (mm)	Size of upper and lower cubital areas (mm)
T. fenestrata	1.8	5.4–5.6	1.1–1.2, 0.5–0.6
T. ruzzieri sp. n.	1.8	3.6	0.7, 0.2
T. danflousi sp. n.	1.0	–	–
T. stichyrata	1.7	7.0–9.0	1.0–1.9, 1.9–2.5
T. banzyvilliana	1.8	4.5–5.0	1.0–1.0
T. smaragdina	1.6	4.9–6.5	0.6–1.0, 0.6–0.9
T. perezi sp. n.	1.8	4.9–5.6	0.6–0.7, 0.6–0.7
T. loubesi sp. n.	2.5	3.5–5.2	0.6–0.8, 0.6–0.9
T. morettoi sp. n.	1.5	4.2–5.4	0.7–0.9, 0.6–0.8
T. n'dokiensis sp. n.	1.4	4.0–6.0	0.5–0.9, 0.5–0.9
T. annoyeri sp. n.	1.5	4.0–6.0	0.5–0.9, 0.6–1.0
T. fijalkowskii sp. n.	1.3	2.9–3.8	0.4–0.5, 0.2–0.5
T. omonomai sp. n.	1.1	3.0–4.5	0.2–0.6, 0.2–0.5
T. aristophanousi sp. n.	1.8	3.9	0.6, 0.6

Table 2. Biometrics of males of the genus *Tetraconcha*. Measurements in mm.

Species	Body length	Length of tegmina	Width of tegmina	Length of hind femur
T. fenestrata	♂: 16.5 (15.2–17.8); ♀: 29.1 (24.0–31.9)	♂: 30.6 (29.8–32.3); ♀: 30.7 (28.4–31.9)	♂: 8.2 (7.9–9.1); ♀: 10.4 (9.2–11.6)	♂: 23.1 (22.4–25.3); ♀: 25.1 (23.3–26.9)
T. ruzzieri **sp. n.**	18.3 (18.0–18.5)	29.8 (27.3–32.4)	6.0 (5.7–6.5)	25.2 (24.9–25.5)
T. danflousi **sp. n.**	16.6	30.3	4.6	27.2
T. stichyrata	♂: 16.0 (15.2–16.5); ♀: 15.5–16.8	♂: 22.0 (21.5–25.5); ♀: 24.2–25.5	♂: 5.2 (4.9–5.5); ♀: 5.0–5.5	♂: 18.2 (17.8–19.0); ♀: 18.1–19.0
T. banzyvilliana	18.0–20.0	27.0–32.0	4.2–5.0	23.4–25.5
T. smaragdina	19.1 (16.4–22.5)	34.1 (30.0–36.7)	5.1 (4.1–5.9)	25.4 (23.7–26.5)
T. perezi **sp. n.**	19.2–20.7	34.0–34.3	3.9–5.0	25.6–25.8
T. loubesi **sp. n.**	16.8 (16.0–18.0)	31.2 (27.9–32.9)	5.1 (4.7–5.8)	25.2 (22.9–26.9)
T. morettoi **sp. n.**	♂: 17.6 (16.0–19.5); ♀: 22.0	♂: 32.2 (29.0–34.5); ♀: 35.5	♂: 5.1 (4.6–5.9); ♀: 7.1	♂: 24.0 (20.8–26.0); ♀: 24.8
T. ndokiensis **sp. n.**	17.5 (14.5–20.5)	32.0 (28.6–37.2)	5.4 (4.5–6.5)	23.1 (20.1–26.0)
T. annoyeri **sp. n.**	17.5 (16.5–19.4)	32.4 (31.6–32.7)	5.0 (4.3–5.9)	23.8 (22.8–24.8)
T. fijalkowskii **sp. n.**	15.4–19.4	29.3–30.1	4.0–4.9	20.1–21.0
T. omonomai **sp. n.**	16.4 (15.5–19.4)	30.9 (29.6–32.1)	4.7 (4.1–5.1)	23.6 (21.2–25.5)
T. aristophanousi **sp. n.**	♂: 16.7 (15.6–18.0); ♀: 26.0	♂: 35.9 (33.5–36.9); ♀: 37.1	♂: 5.3 (4.9–5.8); ♀: 11.2	♂: 26.1 (23.8–27.5); ♀: 25.6

Color.—Head and pronotum yellow-green, abdomen yellow-brown, cerci brown, tegmina green with black spots on the anterior margin and along the diagonal veinlets. A translucent area at the base of tegmina. Like *T. ruzzieri* sp. n., one wide black spot is visible laterally on the metanotum, below the hind wing. This conspicuous character allows to exclude it as male of *T. longipes*, known only from the female sex, also collected in the Ivory Coast, along the coast next to the border with Ghana.

Description.—Male. Head and antennae: Fastigium of vertex flat and sulcate, separated from the fastigium of frons. Eyes rounded, well-projecting. Antennae longer than body. Legs: Fore coxae armed with a small spine. Fore tibiae furrowed above, distinctly widening above tympanum, conchate on both sides. Fore femora armed on inner ventral side with 9 spines, fore tibiae with 7 spines + 1 spur on both ventral sides, 7 spines + 1 spur on outer dorsal side, mid femora armed with 8 spines on anterior ventral side, mid tibiae with 25–26 spines on both ventral sides + 1 spur on each side, and 9 spines + 1 spur on inner dorsal side. Hind femora unarmed, hind tibiae with many spines on both dorsal and ventral sides + 3 spurs on each side. Thorax: Pronotum narrowing anteriorly, flat above, anterior margin incurved, posterior margin rounded, humeral sinus well developed, lateral lobes rounded. Tegmina narrow with rounded apices. Wings longer than tegmina. Stridulatory area of left and right tegmina shown in Fig. 19, characterised by a protruding stridulatory file at the base of the left tegmina, separated by the rest of wing by a concavity (see arrow in Fig. 19) and a translucent area on both bases of tegmina (Fig. 19) that replaces the cubital areas. Stridulatory file curved, ca. 1.0 mm long, composed by ca. 100 very dense and evenly spaced teeth (Fig. 20). Abdomen: Subgenital plate with a "V"-shaped concavity, cerci stout and incurved (Figs 21–22).

Female. Unknown.

Measurements.—Cf. Tables 1 and 2.

Diagnosis.—*T. danflousi* sp. n. may be easily recognised by its translucent area at the base of tegmina, by protruding stridulatory area and a well-developed concavity between the stridulatory area and the rest of the left tegmen (Fig. 19) , the high number of spines on mid tibiae.

Etymology.—This species is dedicated to the French entomologist Samuel Danflous, who collected many interesting insects and spiders in the Taï Forest (Ivory Coast) and kindly helped the author during the nocturnal collecting of Orthoptera.

Distribution.—Known only from Ivory Coast (Taï Forest National Park).

Tetraconcha stichyrata Karsch, 1890 (= *T. scalaris* Brunner von Wattenwyl, 1891)

http://lsid.speciesfile.org/urn:lsid:Orthoptera.speciesfile.org:TaxonName:8784

Figs 23–25, 68, 80, 98

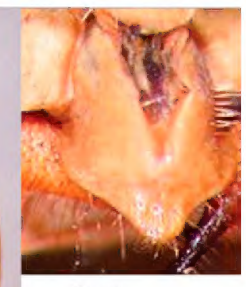
Karsch, 1890b. Entom. Nachricht. 16 (23): 360.

Type material.—Barombi Station (Cameroon) (MfN).

Material examined.—Cameroon, Barombi Station (♂ holotype) (MfN); Cameroon, Rohde (1♀); Gabon (1♂) (NMW); Cameroon (1♂) (MNCN); Ivory Coast, Taï Nat. Park, Research Station 20.III.2017, 05°49'59.8"N, 07°20'32.0"W (light trap), P. Annoyer (1♂); Ivory Coast, Taï Nat. Park, Research Station 20.III.2017 (night), S. Danflous (1♀); Ivory Coast, Taï Nat. Park, Res. Station 4.IV.2017 (light trap), P. Moretto (1♂) (BMPC); Ivory Coast, Taï Nat. Park, Research Station 25.III.2017 (light), P. Annoyer (1♂) (PACT); Central African Republic, Dzanga-N'Doki National Park, Sangha, camp 4, 14.III.2005, P. Annoyer (1♂); Central African Republic, Dzanga-N'Doki National Park, N'Doki, Lake 1, 4.II.2012 (light trap), P. Annoyer (1♂) (PACT); Democratic Republic of Congo, Mulunau (1800 m) 24.V.1970, T. De Stefani (1♀) (MRT).

Remarks.—When Karsch (1891) established the synonymy of *T. scalaris* from Gabon with *T. stichyrata*, he also briefly described the female of *T. stichyrata*, and gave its measurements, including the length (31.5 mm) and width (10 mm) of tegmina; however, according to Karsch (1891) the ratio length/width of tegmina in the males of this species should be 3.1, but it actually varies between 3.0 and 4.6, while in the females it lies between 4.0 and 4.8.

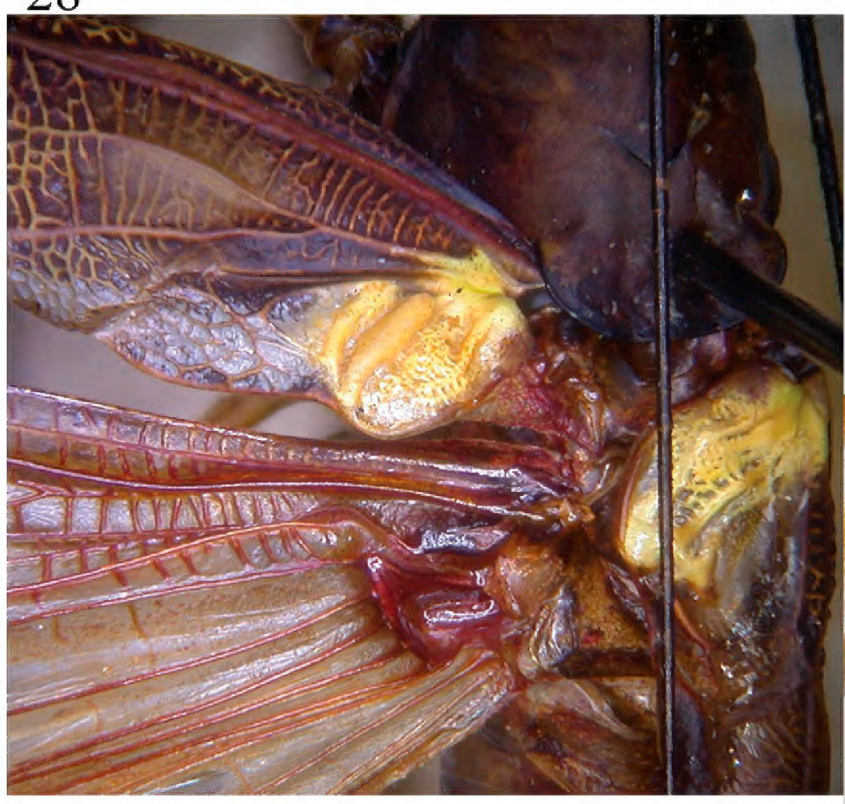
Tetraconcha stichyrata



26 *Tetraconcha banzyvilliana*

Tetraconcha perezi n. sp.

28



29

Figs 23–31. *Tetraconcha stichyrata* male (Ivory Coast, Taï Nat. Park): **23.** Stridulatory area; **24.** Stridulatory file below the left tegmen; **25.** Subgenital plate in ventral view. *Tetraconcha banzyvilliana* male (Cameroon): **26.** Stridulatory area; **27.** Stridulatory file below the left tegmen. *Tetraconcha perezi* sp. n. holotype male (Central African Republic, N'Doki): **28.** Stridulatory area; **29.** Stridulatory file below the left tegmen; **30.** Subgenital plate in ventral view; **31.** Cerci in dorsal view. Fig. 26 after Orthoptera Species File, Fig. 27 after Leroy (1970).

The stridulatory area and stridulatory file of *T. stichyrata* are shown in Figs 23–24; the stridulatory file is ca. 1.7 mm long, curved and consists of ca. 60 evenly spaced teeth; cubital areas are very wide (Fig. 24). The subgenital plate of this species is completely different from that of all other species of the genus being apically pointed not concave (Fig. 25). *T. stichyrata* has tegmina comparatively shorter than other species of the genus, so that the hind wings, when closed, remarkably exceeds the tegmina, both in males and in females.

Distribution.—T. stichyrata has been recorded in Cameroon and Gabon; it is here reported from Ivory Coast. Very probably its distribution covers central and western regions of tropical Africa.

Tetraconcha longipes (Bolívar, 1893)

http://lsid.speciesfile.org/urn:lsid:Orthoptera.speciesfile.org:TaxonName:8789

Fig. 82

Bolívar I., 1893. Ann. Soc. ent. Fr. 62: 178.

Type locality.—Assinie (Ivory Coast).

Material examined.—Ivory Coast, Assinie (♀ holotype) (MNCN).

Remarks and distribution.—Only the female is known from Assinie (Ivory Coast) (Bolívar 1893, 1906). The ratio length/width of tegmina is 3.4. Chopard (1954) also recorded one female from Mt. Nimba (Ivory Coast). However, since now new species are recorded from Ivory Coast it is doubtful that the specimen from Mt Nimba is conspecific with *T. longipes* (see section on female characters). According to Bolívar (1893) this species has small blackish spots along the veinlets of tegmina and the ovipositor is 2.5 mm long.

Tetraconcha banzyvilliana Griffini, 1909

http://lsid.speciesfile.org/urn:lsid:Orthoptera.speciesfile.org:TaxonName:8792

Figs 26–27, 67, 79

Griffini, 1909. Ann. Soc. Entom. Belgique 53: 11.

Type locality.—Banzyville (Zaire = Democratic Republic of Congo) (Museum of Tervuren).

Material examined.—Tanzania, Urwald Beni IX.X.1910, Grauer (1♀) (NMW); Cameroon (1♂, 1♀) (photos in OSF). Other 6 specimens communicated: Central African Republic, Ubangi, Karawa 1939; Democratic Republic of Congo, Uélé, Lakulu 1928–32; Democratic Republic of Congo, Bambesa X-1933 (2); Democratic Republic of Congo, Kasongo; Uganda, Forêt Semliki P.N.A. (900–1200m) X/XI-1937 (S. Hanot, pers. comm.) (RMCA).

Remarks.—When Griffini (1909) described *T. banzyvilliana* on a female, he established to include the species of *Tetraconcha* with long and thin legs to the subgenus *Tellidia*. However, only after the description of the genus *Tellidia* (Bolívar, 1893), Bolívar (1906) realized that it was synonymous with *Tetraconcha*, represented by species characterised by very long legs (see Table 2). Thus, the subgenus *Tellidia* has to be considered definitely synonymous with *Tetraconcha*. Leroy (1970) cited *T. banzyvilliana* from Central African Republic.

The stridulatory area is reported in Fig. 26. We know the pattern of the stridulatory file, thanks to the short and interesting note by Leroy (1970) photographing the structure with a SEM; it is curved and characterized by a proximal part with many dense and evenly spaced teeth and a distal part with few widely spaced teeth (Fig. 27), similar to that of *T. perezi* sp. n. Ratio length/width tegmina in females is 6.5.

Distribution.—It is known from Tanzania, Uganda, Central African Republic, Democratic Republic of Congo and Cameroon (Ragge 1967, Leroy 1970, own data).

Tetraconcha perezi sp. n.

http://lsid.speciesfile.org/urn:lsid:Orthoptera.speciesfile.org:TaxonName:501043

http://zoobank.org/4F380CC6-7259-4055-82BE-4F5C88F27085

Figs 28–31, 73, 96

Material examined and depository.—Central African Republic, N'Doki, shore of Lake 1, 21.X.2010, 02°28'51.0N 016°13'04.5E (UV trap), P. Annoyer (1♂ holotype) (BMPC); Central African Republic, N'Doki National Park, 10.X.2008 (UV trap), P. Annoyer (1♂ paratype) (PACT).

Color.—Head, antennae, pronotum and abdomen brown, face with a yellow spot, cerci yellow, tegmina with a black spot at their base, brown with yellow veinlets, bright yellow in the stridulatory area. Femora yellow-brown or green-brown (Figs 73, 96).

Description.—Males. Head and antennae: Fastigium of vertex tuberculated, narrow, separated from fastigium of frons, little sulcate. Eyes rounded, well projecting. Antennae longer than body, exceeding hind femora, first segment well developed, comparatively to the other species of the genus. Legs: Fore coxae armed with a small spine. Fore tibiae furrowed dorsally, distinctly widening above tympanum, conchate on both sides. Fore femora armed on inner ventral side with 6–7 spines, fore tibiae with 6–7 spines + 1 spur on inner ventral side and 6 small spines on outer ventral side, 5 spines + 1 spur on outer dorsal side, mid femora armed with 6–7 spines on outer ventral margin, mid tibiae with 15–17 spines on outer and inner ventral sides + 1 spur on each side, and 3 spines + 1 spur on inner dorsal side, hind femora armed with 1–2 small spines on outer and inner ventral sides, hind tibiae with many spines on ventral and dorsal sides + 3 spurs on each side. Thorax: Pronotum narrowing anteriorly, flat above, anterior margin straight, posterior margin rounded, humeral sinus well developed, lobes of pronotum rounded. Tegmina narrow with rounded apices. Cubital area of the left tegmen narrow (Table 1). Wings longer than tegmina. Stridulatory area of left and right tegmina shown in Fig. 28; stridulatory file strongly curved and interrupted in the mid section by a bulge, followed by ca. 40 evenly spaced teeth, the distal part is composed of ca. another 40 widely spaced teeth (Fig. 29). Abdomen: Subgenital plate with a very small concavity, cerci stout and much incurved at the tip (Figs 30–31).

Female. Unknown.

Measurements.—Cf. Tables 1 and 2.

Diagnosis.—*T. perezi* sp. n. is very characteristic for the narrow fastigium of the vertex, the bright yellow stridulatory area, the subgenital plate with a very small concavity, cerci stout and strongly incurved, and the uniform brown color.

Etymology.—After the entomologist Cyrille Perez, who participated to the expeditions to Dzangha-N'Doki National Park in 2010 and 2012.

Distribution.—Known only from the Dzanga-N'Doki National Park (Central African Republic).

The 'smaragdina-group'

Generally, most specimens not belonging to any of previous species, with a pattern of *T. smaragdina*, having a small black spot at the base of tegmina, were identified as *T. smaragdina*. In fact, they actually belong to a group of species, morphologically very similar, but separate by the following characters: stridulatory file, stridulatory area, color of veinlets of tegmina, subgenital plate and cerci shape. Within the material collected by Philippe Annoyer and Philippe Moretto in the Central African Republic in 2005–2012 it was possible to identify other six undescribed species. Among the specimens collected by Philippe Annoyer, Marios Aristophanous, Samuel Danflous, Philippe Moretto, Enrico Ruzzier and myself in the Ivory Coast in 2014, 2015, 2016 and 2017 another undescribed species was discovered. Thus seven new taxa of the "*smaragdina*-group" are new to science.

Tetraconcha smaragdina Brunner von Wattenwyl, 1891

http://lsid.speciesfile.org/urn:lsid:Orthoptera.speciesfile.org:TaxonName:8788

Figs 32–36, 70, 84, 88

Brunner von Wattenwyl, 1891. Verh. der Zoologisch-Botanischen Gesellsch. Wien 41: 115, 116.

Type locality.—Cameroon (NMW).

Material examined.—Cameroon, Mus. Lubeck. (♂ holotype); Cameroon, Mundame, Rohde (1♂) (NMW); Cameroon, Lolodorf, L. Conradt (1♂) (MfN); Cameroon (1♂) (MNCN); Central African Republic, N'Doki, shore of Lake 1, UV trap 31.I-2.II.2012, 13–14.II.2012, 15–16.II.2012, 20–23.II.2012, P. Moretto (8♂); Central African Republic, surroundings of Bambio 10.XII.2008, J. Halada (1♂) (BMPC); Central African Republic, Dzanga-N'Doki National Park, Sangha, camp 3, 9.II.2005, P. Annoyer (1♂); Central African Republic, Dzanga-N'Doki National Park, Sangha, camp 2, 24.X.2008, P. Annoyer (1♂); Central African Republic, Dzanga-N'Doki National Park, N'Doki, 10.X.2008 (light trap), P. Annoyer (1♂); Central African Republic, N'Doki, shore of Lake 1, UV trap 29.I.2012, 4.II.2012, 13.II.2012, 14.II.2012, 16.II.2012, 24.II.2012, 25.II.2012, 27.II.2012, P. Annoyer (7♂); Central African Republic, N'Doki, butterfly trap 14.XI.2010, P. Annoyer (1♂); Central African Republic, N'Doki, shore of lake 7, UV trap 1.III.2012, P. Annoyer (1♂); Central African Republic, Dzanga-N'Doki National Park, N'Doki, Lake 3, 25.II.2012 (light trap), P. Annoyer (1♂) (PACT); Cameroon, Mukonje Farm, R. Rohde (1♀); Democratic Republic of Congo, N Mosso Norma, Las Tumba 31.VII.1938 (1♂) (RBINS).

Remarks.—The type specimen, considered as probably lost (Cigliano et al. 2017), was actually found again in the Naturhistorisches Museum, Vienna (coll. Brunner von Wattenwyl). The label of the specimen reports "Mus. Lubeck."; because Brunner von Wattenwyl (1891) wrote in the description "Kamerun, Mus. Lubecanum", it is evident that this specimen is the holotype. Its characters fit well to the short description. The examination of characters of the holotype (Figs 33, 36) allowed the comparison with other undescribed species.

Redescription.—Males. Head and antennae: Fastigium of vertex narrow, sulcate above, separated from fastigium of frons, furrowed. Eyes rounded, well projecting. Antennae longer than body. Legs: Fore coxae armed with a small spine. Fore tibiae furrowed dorsally, distinctly widening above tympanum, conchate on both sides. Fore femora armed on inner ventral side with 7–10 spines, fore tibiae with 6–7 spines + 1 spur on inner side and 3–4 small spines on outer ventral side, 3 spines + 1 spur on outer dorsal side, mid femora armed with 7–8 spines on outer ventral side, mid tibiae with 12–13 spines on outer and inner ventral sides + 1 spur on each side, and 3 spines + 1 spur on inner dorsal side, hind femora armed with 2–5 small spines on the outer [Brunner von Wattenwyl (1891) recorded 5 spines] and 1–2 on inner ventral sides, hind tibiae with many spines on ventral and dorsal sides + 3 spurs on each side. Thorax: Pronotum narrowing anteriorly, flat above, anterior margin incurved, posterior margin rounded, humeral sinus well developed, lobes of pronotum rounded. Tegmina narrow with rounded apices. Wings longer than tegmina. Stridulatory area of left and right tegmina shown in Figs 32–33, veinlets of left tegmen in Fig. 88; stridulatory file arched and composed of ca. 65–70 dense and evenly spaced teeth plus 3–4 widely spaced teeth in the distal part (Fig. 34). Abdomen: Subgenital plate long and apically narrowed with a narrow concavity protruding beyond cerci, and two longitudinal carinae on the sides; cerci stout at their base and incurved (Figs 35–36).

Female. Bolívar (1906) described the female, but considering the presence and the co-occurrence of more than one species of the '*smaragdina*-group', the description cannot be considered to belong to *T. smaragdina* for certain. One female collected in Cameroon (Mukonje Farm) and dubiously reported by Griffini (1908) as *T. smaragdina*, very probably belongs to this species. The ratio length/width of tegmina in the specimen cited by Griffini (1908) is 4.6 (Fig. 84).

Diagnosis.—Characters of *T. smaragdina* are: stridulatory area of left and right tegmina and stridulatory file as in Figs 32–33 and 34, subgenital plate of male long and narrow with two parallel longitudinal keels, ending with a narrow concavity, protruding beyond cerci, when viewed from above (Fig. 35).

Measurements.—Cf. Tables 1 and 2.

Distribution.—*T. smaragdina* is present in Cameroon, the Democratic Republic of Congo and Central African Republic; according to Ragge (1967) very probably its distribution covers all Central Africa from Democratic Republic of Congo to Liberia, but in the present paper the high diversity of the '*smaragdina* group' is shown, and many records from some countries possibly have to be referred to other species.

Tetraconcha loubesi sp. n.

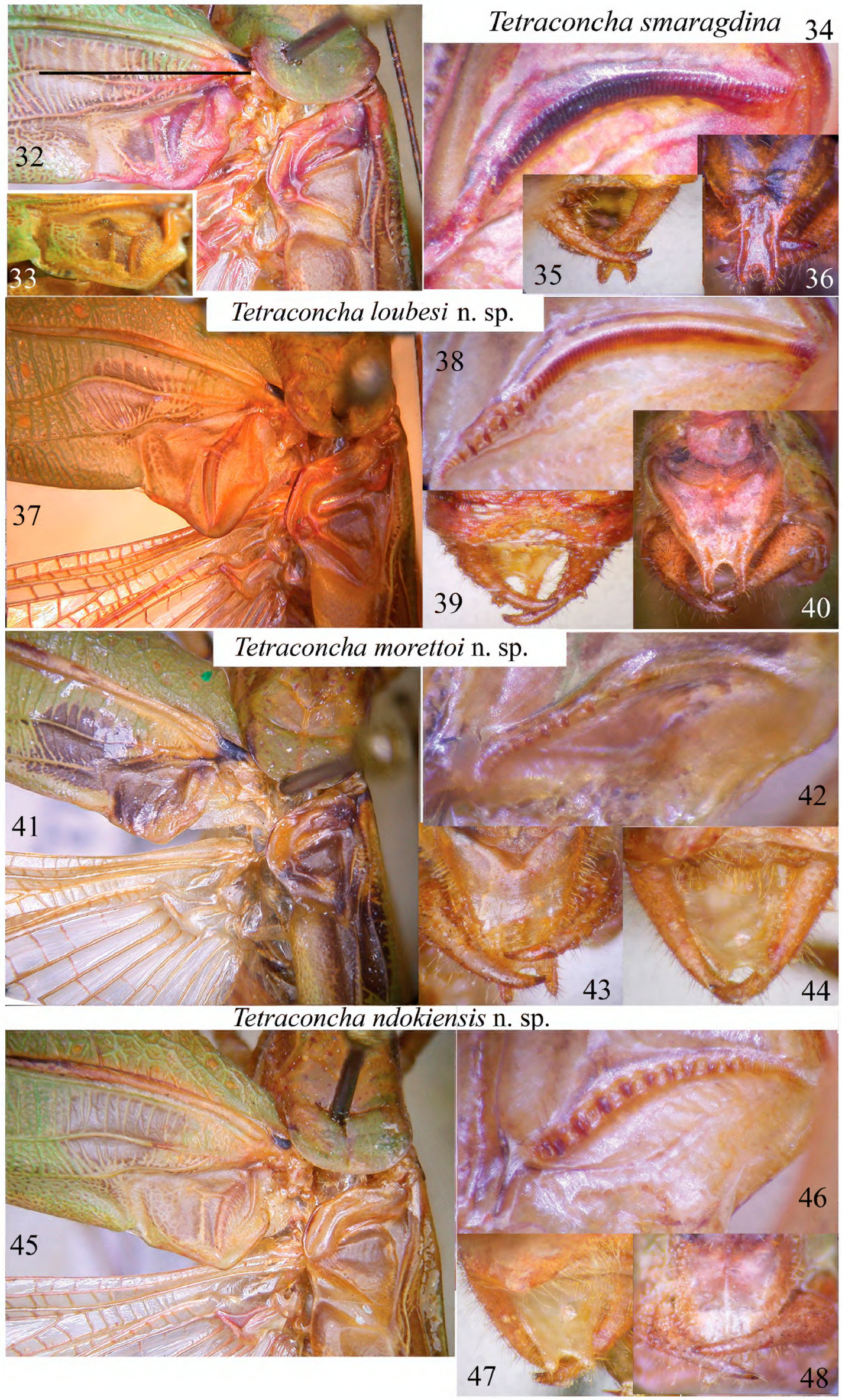
http://lsid.speciesfile.org/urn:lsid:Orthoptera.speciesfile.org:TaxonName:501044

http://zoobank.org/4D74E9C4-870C-445A-A7E4-88429B6CDE9C

Figs 37–40, 74, 89

Material examined and depository.—Central African Republic, N'Doki, shore of Lake 1, 20–23.II.2012, 02°28'51.0N, 016°13'04.5E (UV trap), P. Moretto (1♂ holotype) (MSNG); same data 4–5.II.2012, 13–14.II.2012, 20–23.II.2012 (UV trap), P. Moretto (5♂ paratypes) (BMPC); Central African Republic, Dzanga-N'Doki National Park, N'Doki, Lake 1, 25.XI.2010, 14.II.2012 (light trap), P. Annoyer (2♂ paratypes) (PACT).

Color.—Head and pronotum yellow-green, abdomen yellow-brown, cerci yellow, tegmina with a black spot at their base, green with black spots on back veinlets, brownish in the stridulatory area.



Figs 32–48. *Tetraconcha smaragdina* male (Central African Republic, N'Doki): **32.** Stridulatory area (the arrow shows the distance between the base of left tegmen and the maximum width of cubital areas); **33.** Stridulatory area of the holotype (Cameroon); **34.** Stridulatory file below the left tegmen; **35.** Cerci in dorsal view; **36.** Subgenital plate in ventral view of the holotype. *Tetraconcha loubesi* sp. n. holotype male (Central African Republic, N'Doki): **37.** Stridulatory area; **38.** Stridulatory file below the left tegmen; **39.** Cerci in dorsal view; **40.** Subgenital plate in ventral view). *Tetraconcha morettoi* sp. n. holotype male (Central African Republic, N'Doki): **41.** Stridulatory area; **42.** Stridulatory file below the left tegmen; **43.** Subgenital plate in ventral view; **44.** Cerci in dorsal view. *Tetraconcha ndokiensis* sp. n. holotype male (Central African Republic, N'Doki): **45.** Stridulatory area; **46.** Stridulatory file below the left tegmen; **47.** Subgenital plate and cerci in dorsal view; **48.** Subgenital plate and cerci in ventral view.

Description.—Males. Head and antennae: Fastigium of vertex narrow, sulcate above, separated from fastigium of frons. Eyes rounded, well projecting. Antennae longer than body. Legs: Fore coxae armed with a small spine. Fore tibiae furrowed dorsally, distinctly widening above tympanum, conchate on both sides. Fore femora armed on inner ventral side with 9–10 spines, fore tibiae with 6–7 spines + 1 spur on inner side and 3–4 small spines on outer ventral side, 2 spines + 1 spur on outer dorsal side, mid femora armed with 7–8 spines on outer ventral side, mid tibiae with 15–17 spines on outer and inner ventral sides + 1 spur on each side, and 3 spines + 1 spur on inner dorsal side, hind femora armed with 5–6 small spines on outer and 1–2 on inner ventral sides, hind tibiae with many spines on ventral and dorsal sides + 3 spurs on each side. Thorax: pronotum narrowing anteriorly, flat above, anterior margin incurved, posterior margin rounded, humeral sinus well developed, lobes of pronotum rounded. Tegmina narrow with rounded apices. Wings longer than tegmina. Stridulatory area of left and right tegmina shown in Fig. 37, veinlets of left tegmen in Fig. 89; stridulatory file arched and composed of ca. 100 very dense and evenly spaced teeth plus 7–8 widely spaced teeth in the distal part, followed by ca. 6–7 very small and little raised teeth (Fig. 38). Abdomen: Subgenital plate with a deep concavity, cerci stout at their base and incurved (Figs 39–40).

Female: unknown.

Measurements.—Cf. Tables 1 and 2.

Diagnosis.—*T. loubesi* is very similar to *T. smaragdina*, from which it may be separated by a different stridulatory area of the left and right tegmen (compare Figs 32 and 37) and the stridulatory file (compare Figs 34 and 38). It also differs by veinlets on tegmina (compare Figs 88 and 89) and by the male subgenital plate ending in a short apical part with a deep concavity (compare Figs 36 and 40). Cerci are stout at their base (Figs 39–40).

Etymology.—This species is named after Matias Loubes, President of the Association Tout Là-Haut, responsible for the at light captures within the forest canopy during the expedition Sangha 2012 and the expedition to Taï Forest in 2017.

Distribution.—Known only from Central African Republic.

Tetraconcha morettoi sp. n.

http://lsid.speciesfile.org/urn:lsid:Orthoptera.speciesfile.org:TaxonName:501045

http://zoobank.org/75C11B45-5711-48FA-9B86-9EFF33D857B0

Figs 41–44, 72, 85, 90

Material examined and depository.—Central African Republic, N'Doki, shore of Lake 1, 29.II-1.III.2012, 02°28'51.0N 016°13'04.5E (UV trap), P. Moretto (1♂ holotype) (MSNG); same data 31.I-2.II.2012, 5–6.II.2012, 13–14.II.2012, 20–23.II.2012 (UV trap), P. Moretto (9♂ paratypes); Central African Republic, Dzanga-N'Doki National Park, N'Doki, Lake 1, 3.III.2012 (light trap), P. Annoyer (1♀ paratype) (BMPC); Central African Republic, Dzanga-N'Doki National Park, Sangha, camp 3, 9.II.2005, P. Annoyer (1♂ paratype); Central African Republic, Dzanga-N'Doki National Park, Sangha 10.X.2008, P. Annoyer (1♂ paratype); Central African Republic, Dzanga-N'Doki National Park, N'Doki, Lake 1, 12.II.2012, 19.II.2012, 3.III.2012 (light trap), P. Annoyer (4♂ paratypes); Central African Republic, Dzanga-N'Doki National Park, N'Doki, camp 1, II.2012 (light trap), P. Annoyer (1♂ paratype) (PACT).

Color.—Head and pronotum yellow-green, abdomen yellow-brown, cerci black, tegmina with a black spot at their base, green with black spots on veinlets, in most specimens the stridulatory area is brown (Fig. 41).

Description.—Males. Head and antennae: Fastigium of vertex narrow, sulcate above, separated from fastigium of frons. Eyes rounded, well projecting. Antennae longer than body. Legs: Fore coxae armed with a small spine. Fore tibiae furrowed on upper margin, distinctly widening above tympanum, conchate on both sides. Fore femora armed on inner ventral side with 10–12 spines, fore tibiae with 5 spines + 1 spur on inner side and 2 spines on outer ventral side, 2 spines + 1 spur on outer dorsal side, mid femora armed with 7–8 spines on outer ventral side, mid tibiae with 10–12 spines on outer and inner ventral sides + 1 spur on each side, and 3 spines + 1 spur on inner dorsal side, hind femora armed with 5–6 small spines on outer and 1–2 on inner ventral sides, hind tibiae with many spines on ventral and dorsal sides + 3 spurs on each side. Thorax: Pronotum narrowing anteriorly, flat above, anterior margin incurved, posterior margin rounded, humeral sinus well developed, lobes of pronotum rounded. Tegmina narrow with rounded apices. Wings longer than tegmina. Stridulatory area of left and right tegmina shown in Fig. 41, veinlets of left tegmen in Fig. 90; stridulatory file arched and composed by ca. 20 very dense, little raised and evenly spaced teeth in the proximal part (ca. 1/3 of the length), and ca. 14–15 widely spaced teeth in the distal part (ca. 2/3 of the length) (Fig. 42) Abdomen: Subgenital plate large and short with a fairly developed concavity, cerci slender, fairly straight and incurved at the tip (Figs 43–44).

Female (Fig. 85). A female was collected together with some males. It has the same characters of the male except of the following: The color of the fore legs, mid tibiae and first antennal segments are blackish, tegmina green with brownish veinlets. Fore femora with 6 spines, mid femora with 8 spines and hind femora with 4 spines. The ovipositor is very short (2.5 mm).

Measurements.—Cf. Tables 1 and 2; length of the ovipositor: 2.5 mm.

Diagnosis.—*T. morettoi* is characterised mainly by black cerci, its stridulatory area of left and right tegmina (Fig. 41), by its stridulatory file (Fig. 42), veinlets of tegmina (Fig. 90), the subgenital plate, that is similar to that of *T. loubesi*, but cerci are more slender (compare Figs 39–40 and 43–44).

Etymology.—This species is gratefully named after the French colleague Philippe Moretto, who collected a long series of specimens of *Tetraconcha* and other interesting species from the Central African Republic and the Ivory Coast.

Distribution.—Known only from Central African Republic.

Tetraconcha ndokiensis sp. n.

http://lsid.speciesfile.org/urn:lsid:Orthoptera.speciesfile.org:TaxonName:501046

http://zoobank.org/D0951B4C-AF8C-427A-8669-DD3D4E72EE21

Figs 45–48, 94

Material examined and depository.—Central African Republic, N'Doki, shore of Lake 1, 20–23.II.2012, 02°28'51.0N 016°13'04.5E (UV trap) P. Moretto (1♂ holotype) (MSNG); Central African Republic, Dzanga-N'Doki National Park, M'boki, 2.II.2012 (light trap), P. Annoyer (1♂ paratype); Central African Republic, Dzanga-N'Doki National Park, N'Doki, Lake 1, 14.II.2012, 22.II.2012 (light trap), P.

Annoyer (2♂ paratypes); Central African Republic, Dzanga-N'Doki National Park, N'Doki, Lake 7, 3.II.2012 (light trap), P. Annoyer (1♂ paratype) (BMPC); Central African Republic, Dzanga-N'Doki National Park, Sangha platform (54m) 23.X.2008, P. Annoyer (1♂ paratype); Central African Republic, Dzanga-N'Doki National Park, N'Doki, Lake 1, 14–15.II.2012, 19.II.2012, 22.II.2012 (light trap), P. Annoyer (5♂ paratypes) (PACT).

Color.—Head and pronotum yellow-green, abdomen yellow-brown, tegmina with a black spot at their base, green with yellow spots between veinlets.

Description.—Males. Head and antennae: Fastigium of vertex narrow, sulcate dorsally, separated from fastigium of frons. Eyes rounded, well projecting. Antennae long. Legs: Fore coxae armed with a small spine. Fore tibiae furrowed on upper margin, distinctly widening above tympanum, conchate on both sides. Fore femora armed on inner ventral side with 6–7 spines, fore tibiae with 4–5 spines + 1 spur on inner side and 3 spines on outer ventral side, 3 spines + 1 spur on outer dorsal side, mid femora armed with 6–7 spines on outer ventral side, mid tibiae with 15–16 spines on outer and inner ventral sides + 1 spur on each side, and 4 spines + 1 spur on inner dorsal side, hind femora armed with 6–7 small spines on outer and 1–2 on inner ventral sides, hind tibiae with many spines on ventral and dorsal sides + 3 spurs on each side. Thorax: Pronotum narrowing anteriorly, flat above, anterior margin incurved, posterior margin rounded, humeral sinus well developed, lobes of pronotum rounded. Tegmina narrow with rounded apices. Wings longer than tegmina. Stridulatory area of left and right tegmina shown in Fig. 45, veinlets of left tegmen in Fig. 94; stridulatory file curved and composed of ca. 30 very dense and evenly spaced teeth in the proximal part (ca. ¼ of the length), and 8–10 widely spaced teeth in the distal part (ca. ¾ of the length) (Fig. 46). Abdomen: Subgenital plate short with a little concavity, cerci slender and incurved (Figs 47–48).

Female. Unknown.

Measurements.—Cf. Tables 1 and 2.

Diagnosis.—*T. ndokiensis* is characterised mainly by the presence of yellow spots between veinlets of tegmina (Fig. 94), its stridulatory area of left and right tegmina (Fig. 45), its peculiar stridulatory file (Fig. 46) and its subgenital plate (Figs 47–48).

Etymology.—After the latinized name of N'Doki, the locality where it was collected, Dzanga-N'Doki National Park in the Central African Republic.

Distribution.—Known only from Central African Republic.

Tetraconcha annoyeri sp. n.

http://lsid.speciesfile.org/urn:lsid:Orthoptera.speciesfile.org:TaxonName:501047

http://zoobank.org/3F1399C3-9D1F-4AAC-B380-A96E2C30373E

Figs 49–52, 91, 100

Material examined and depository.—Central African Republic, N'Doki, shore of Lake 1, 11–12.II.2012, 02°28'51.0N 016°13'04.5E (UV trap), P. Moretto (1♂ holotype) (MSNG); same locality 20–23.II.2012, P. Moretto (1♂ paratype); same locality 24–25.II.2012, P. Moretto (1♂ paratype); Central African Republic, Dzanga-N'Doki National Park, N'Doki, Lake 1, 21.II.2012 (light trap), P. Annoyer (1♂ paratype) (BMPC); Central African Republic, Dzanga-N'Doki National Park, Sangha, camp 3, 6.II.2005, P. Annoyer (1♂ paratype); Central African Republic, Dzanga-N'Doki National Park, N'Doki, Lake 1, 29.XI.2010, 11.II.2012 (light trap), P. Annoyer (2♂ paratypes); Central African Republic, Dzanga-N'Doki National Park, N'Doki, Lake 2, 24.II.2012 (light trap), P. Annoyer (1♂ paratype) (PACT).

Color.—The whole body yellowish, tegmina with a black spot at the base, many yellowish or whitish spots between veinlets; black spots along the veinlets of posterior area of tegmina; ventral side of hind femora generally brownish.

Description.—Males. Head and antennae: Fastigium of vertex narrow, sulcate above, separated from fastigium of frons. Eyes rounded, well projecting. Antennae long. Legs: Fore coxae armed with a small spine. Fore tibiae furrowed dorsally, distinctly widening above tympanum, conchate on both sides. Fore femora armed on inner ventral side with 7–8 spines, fore tibiae with 5–6 spines + 1 spur on inner and on outer ventral sides, 3 spines + 1 spur on outer dorsal side, mid femora armed with 8–9 spines on outer ventral side, mid tibiae with 15–16 spines on outer and inner ventral sides + 1 spur on each side, and 4–5 spines + 1 spur on inner dorsal side, hind femora armed with 6 small spines on outer and 3 on inner ventral sides, hind tibiae with many spines on ventral and dorsal sides + 3 spurs on each side. Thorax: Pronotum narrowing anteriorly, flat above, anterior margin incurved, posterior margin rounded, humeral sinus well developed, lobes of pronotum rounded. Tegmina narrow with rounded apices. Wings longer than tegmina. Stridulatory area of left and right tegmina shown in Fig. 49, veinlets of left tegmen in Fig. 91; stridulatory file arched and composed by ca. 100 very dense and evenly spaced teeth in the proximal part (ca. 1/3 of the length), and 15 widely spaced teeth in the distal part (ca. 2/3 of the length) (Fig. 50). Abdomen: Subgenital plate short with a wide concavity, cerci slender and incurved (Figs 51–52).

Female. Unknown.

Measurements.—Cf. Tables 1 and 2.

Diagnosis.—*T. annoyeri* sp. n. is characterised mainly by the presence of whitish-yellow spots on tegmina (Fig. 91), its stridulatory area of left and right tegmina (Fig. 49), its peculiar stridulatory file (Fig. 50) and its subgenital plate (Figs 51–52).

Etymology.—This species is named after Philippe Annoyer, President of the Association Insectes du Monde and organizer of the expedition Sangha 2012; he also collected many interesting Orthoptera during the expedition to the Taï Forest (Ivory Coast) in 2017.

Distribution.—Known only from Central African Republic.

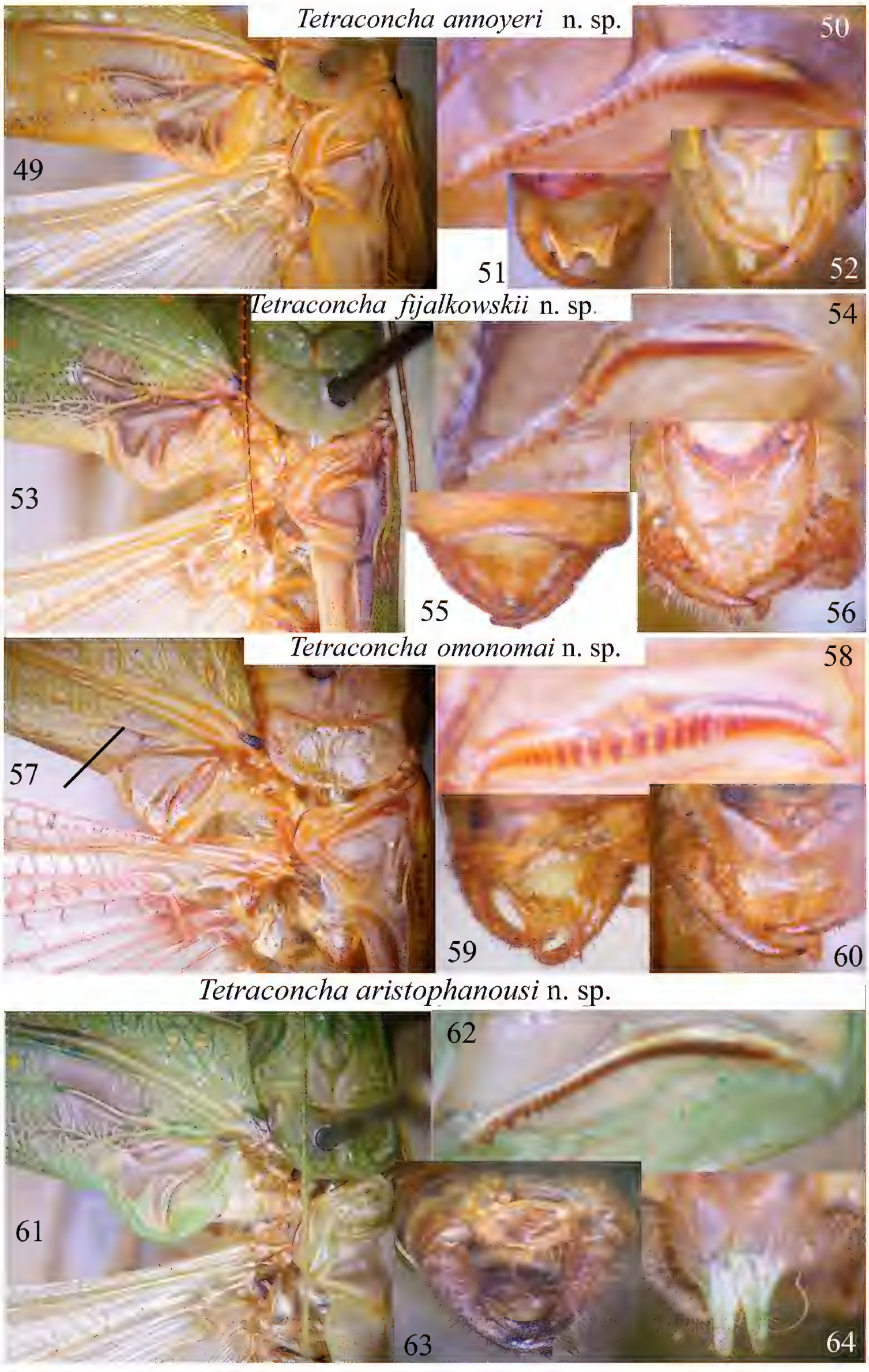
Tetraconcha fijalkowskii sp. n.

http://lsid.speciesfile.org/urn:lsid:Orthoptera.speciesfile.org:TaxonName:501048

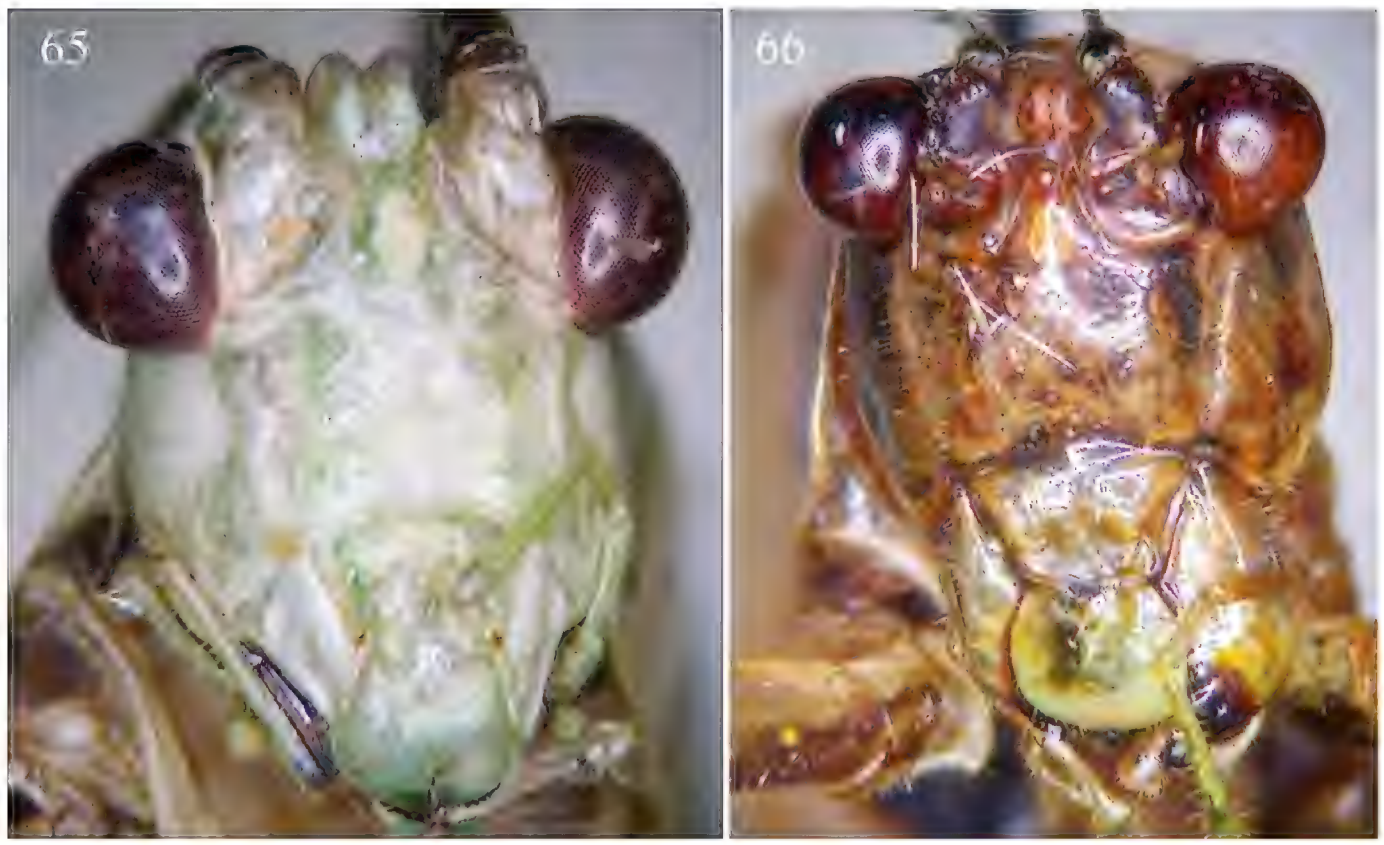
http://zoobank.org/9EB4FDAF-9890-4181-9240-E8C8FACE8A73

Figs 53–56, 92

Material examined and depository.—Central African Republic, N'Doki, shore of Lake 1, 20–23.II.2012, 02°28'51.0N 016°13'04.5E



Figs 49–64. *Tetraconcha annoyeri* sp. n. holotype male (Central African Republic, N'Doki): **49.** Stridulatory area; **50.** Stridulatory file below the left tegmen; **51.** Cerci and subgenital plate in dorsal view; **52.** Cerci and subgenital plate in ventral view. *Tetraconcha fijalkowskii* sp. n. holotype male (Central African Republic, N'Doki): **53.** Stridulatory area; **54.** Stridulatory file below the left tegmen; **55.** Cerci and subgenital plate in dorsal view; **56.** Cerci and subgenital plate in ventral view. *Tetraconcha omonomai* sp. n. holotype male (Central African Republic, N'Doki): **57.** Stridulatory area (the arrow shows the cubital areas); **58.** Stridulatory file below the left tegmen; **59.** Cerci and subgenital plate in dorsal view; **60.** Cerci and subgenital plate in ventral view. *Tetraconcha aristophanousi* sp. n. holotype male (Ivory Coast, Taï Nat. Park): **61.** Stridulatory area; **62.** Stridulatory file below the left tegmen; **63.** Cerci and subgenital plate in dorsal view; **64.** Cerci and subgenital plate in ventral view.



Figs 65–66. *Tetraconcha aristophanousi*: **65.** Male, face in frontal view; **66.** Female, face in frontal view.

(UV trap), P. Moretto (1♂ holotype) (BMPC); Central African Republic, Dzanga-N'Doki National Park, Boda-N'Gotto, 20.I.2005 (light trap), P. Annoyer (1♂ paratype) (PACT).

Color.—Head and pronotum yellow-green, abdomen yellow-brown, tegmina with a black spot at their base, green with yellow spots between veinlets.

Description.—Males. Head and antennae: Fastigium of vertex narrow, sulcate above, separated from fastigium of frons. Eyes rounded, well projecting. Antennae long. Legs: Fore coxae armed with a small spine. Fore tibiae furrowed dorsally, distinctly widening above tympanum, conchate on both sides. Fore femora armed on inner ventral side with 8–9 spines, fore tibiae with 4–5 spines + 1 spur on inner and on outer ventral sides, 2–3 spines + 1 spur on outer dorsal side, mid femora armed with 5 spines on outer ventral side, mid tibiae with 13 spines on outer and inner ventral sides + 1 spur on each side, and 4 spines + 1 spur on inner dorsal side, hind femora armed with 5 small spines on outer ventral side, hind tibiae with many spines on ventral and dorsal sides + 3 spurs on each side. Thorax: Pronotum narrowing anteriorly, flat above, anterior margin incurved, posterior margin rounded, humeral sinus well developed, lobes of pronotum rounded. Tegmina narrow with rounded apices. Wings longer than tegmina. Stridulatory area of left and right tegmina shown in Fig. 53, veinlets of left tegmen in Fig. 92; stridulatory file angularly arched and composed of ca. 120 very dense and evenly spaced teeth in the proximal part (ca. 2/3 of the length), and 6 widely spaced teeth in the distal part (ca. 1/3 of the length) (Fig. 54). Abdomen: Subgenital plate short with a little concavity, its appendices close together, cerci stout and incurved (Figs 55–56).

Female. Unknown.

Measurements.—Cf. Tables 1 and 2.

Diagnosis.—*T. fijalkowskii* sp. n. is characterised mainly by the presence of yellow spots on tegmina (Fig. 92), its stridulatory area of the left and right tegmina (Fig. 53), its peculiar stridulatory file (Fig. 54), its subgenital plate with narrow appendices (Figs 55–56). Note also the short size of the hind femur.

Etymology.—*T. fijalkowskii* sp. n. is named after Jean-Louis Fijalkowski, logistics helper in Bangui during the preparation of the expedition Sangha 2012.

Distribution.—Known only from Central African Republic.

Tetraconcha omonomai sp. n.

http://lsid.speciesfile.org/urn:lsid:Orthoptera.speciesfile.org:TaxonName:501049

http://zoobank.org/321EDD45-9E78-450D-9952-200112F1B574

Figs 57–60, 93

Material examined and depository.—Central African Republic, N'Doki, shore of Lake 1, 13–14.II.2012, 02°28'51.0N 016°13'04.5E (UV trap), P. Moretto (1♂ holotype) (MSNG); Central African Republic, Dzanga-N'Doki National Park, N'Doki, Lake 1, 15.II.2012 (light trap), P. Annoyer (1♂ paratype); Central African Republic, Dzanga-N'Doki National Park, N'Doki, Lake 1, 24.II.2012 (light trap), P. Annoyer (1♂ paratype) (BMPC); Central African Republic, Dzanga-N'Doki National Park, Sangha National Park, camp 3, 5.II.2005, P. Annoyer (1♂ paratype); Central African Republic, Dzanga-N'Doki National Park, N'Doki, Lake 1, 19.II.2012 (light trap), P. Annoyer (1♂ paratype); Central African Republic, Dzanga-N'Doki National Park, N'Doki, Lake 1, 1.II.2012, 16.II.2012 (light trap), P. Annoyer (2♂ paratypes) (PACT).

Color.—Head and pronotum yellow-green, abdomen yellow-brown, tegmina with a black spot at their base, green.

Description.—Males. Head and antennae: Fastigium of vertex narrow, sulcate above, separated from fastigium of frons. Eyes rounded, well projecting. Antennae long. Legs: Fore coxae armed with a small spine. Fore tibiae furrowed dorsally, distinctly widening above tympanum, conchate on both sides. Fore femora armed on inner ventral side with 4–5 spines, fore tibiae with 4–5 spines + 1 spur on inner and on outer ventral sides, 3 spines + 1 spur on outer dorsal side, mid femora armed with 6–7 spines on outer ventral side, mid tibiae with 7–9 spines on outer and inner ventral sides + 1 spur on each side, and 4 spines + 1 spur on inner dorsal side, hind femora

armed with 6–7 small spines on outer ventral side, hind tibiae with many spines on ventral and dorsal sides + 3 spurs on each side. Thorax: Pronotum narrowing anteriorly, flat above, anterior margin incurved, posterior margin rounded, humeral sinus well developed, lobes of pronotum rounded. Tegmina narrow with rounded apices. Compared to other species of the "*smaragdina*-group" cubital area between cubitus of the left tegmen narrower (Table 1). Wings longer than tegmina. Stridulatory area of left and right tegmina shown in Fig. 57, veinlets of left tegmen in Fig. 93; stridulatory file arched and composed by ca. 30 very dense and evenly spaced teeth in the distal part (ca. ¼ of the length), ca. 15 widely spaced teeth in the central part (ca. 2/4 of the length), and ca. 10 dense and evenly spaced teeth in the proximal part (ca. ¼ of the length) (Fig. 58). Abdomen: Subgenital plate long with a wide concavity, cerci slender, fairly straight and incurved at the tip (Figs 59–60).

Female. Unknown.

Measurements.—Cf. Tables 1 and 2.

Diagnosis.—*T. omonomai* sp. n. is characterised mainly by the narrow cubital area of the left tegmen, its stridulatory area of the left and right tegmina (Fig. 57), its peculiar stridulatory file (Fig. 58), veinlets of tegmina (Fig. 93), and long subgenital plate with wide concavity (Figs 59–60).

Etymology.—This species is named after Dieu béni Bongola Omonoma, local collector of insects within the forest during the expedition Sangha 2012.

Distribution.—Known only from Central African Republic.

***Tetraconcha aristophanousi* sp. n.**

http://lsid.speciesfile.org/urn:lsid:Orthoptera.speciesfile.org:TaxonName:501050

http://zoobank.org/8DA02FC2-3E82-4338-972A-03EB7A0859AA

Figs 61–64, 83, 95

Material examined and depository.—Ivory Coast, Taï Nat. Park, Res. Station 5–10.VII.2015, 05°49'59.8"N, 07°20'32.0"W (light trap), M. Aristophanous, P. Moretto, E. Ruzzier (1♂ holotype, 3♂ paratypes) (NHM); Ivory Coast, Man, Mt. Tonkoui (1171m) 12–18. VII.2015, 07°26'41.9"N, 07°38'40.8"W (light trap), M. Aristophanous, P. Moretto, E. Ruzzier (1♀ paratype) (NHM); Ivory Coast, Man, Mt. Tonkoui (1200m) 29.VI-1.VII.2014, (UV trap), P. Moretto (1♂ paratype) (MSNG); Ivory Coast, Touba, Biémasso 10–11.VII.2013, 08°04'19.9"N, 07°33'05.6"W (UV trap), P. Moretto (1♂ paratype); Ivory Coast, Taï Nat. Park, Res. Station 19–20.III.2017 (light trap, platform 40 m), B. Massa (2♂ paratypes); Ivory Coast, Taï Nat. Park, Res. Station 21.III.2017 (night), S. Danflous (1♀ paratype); Ivory Coast, Taï Nat. Park, Res. Station 4.IV.2017 (light trap), P. Moretto (3♂ paratypes); Ivory Coast, Taï Nat. Park, Res. Station 2–3.IV.2017 (light trap), P. Moretto (4♂ paratypes) (BMPC); Ivory Coast, Taï Nat. Park, Res. Station 2.IV.2017 (light), P. Annoyer (1♂ paratype) (PACT); Sierra Leone, Bumbuna 6.XI.1991, W. Rossi (1♂ paratype) (coll. La Greca, MSNM).

Color.—Head and pronotum green-brown, abdomen brown, tegmina green with some yellow spots between veinlets, abdomen brown, cerci brown.

Description.—Males. Head and antennae: Fastigium of vertex narrow, sulcate above, separated from fastigium of frons. Eyes rounded, well projecting. Antennae long. Legs: Fore coxae armed with a small spine. Fore tibiae furrowed dorsally, distinctly widening above tympanum, conchate on both sides. Fore femora armed on inner ventral side with 13–14 spines, fore tibiae with 6 spines + 1 spur on inner and on outer ventral sides, 1–3 spines + 1 spur on outer dorsal side, mid femora armed with 10–12 spines on outer ventral side, mid tibiae with 14–15 spines on outer and inner ventral sides + 1 spur on each side, and 3–4 spines + 1 spur on inner dorsal side, hind femora armed with 7–8 small spines on outer and 1–2 on inner ventral sides, hind tibiae with many spines on ventral and dorsal sides + 3 spurs on each side. Thorax: Pronotum narrowing anteriorly, flat above, anterior margin incurved, posterior margin rounded, humeral sinus well developed, lobes of pronotum rounded. Tegmina narrow with rounded apices. Wings longer than tegmina. Stridulatory area of left and right tegmina shown in Fig. 61, veinlets of left tegmen in Fig. 95; stridulatory file arched and composed of ca. 100 teeth, 75–80 dense and evenly spaced teeth in the proximal half, and ca. 20–22 widely spaced teeth in the distal half (Fig. 62). Abdomen: Subgenital plate long and with a more or less narrow and deep concavity, cerci stout, fairly straight and incurved at the tip (Figs 63–64).

Female. Two females collected in the same area with some males (Mt. Tonkoui and Taï Nat. Park, Res. Station) were available, and it is also possible to describe this sex, which resulted to be clearly different from *T. longipes* (compare Figs 82 and 83), also described from the Ivory Coast, along the coast next to the border with Ghana. Same characters of the male, with the following differences: Body stout, tegmina wider than in males (see Table 2), tubercle of frons much smaller, and mandibles stouter than in males (Figs 65–66). Coxae armed with a very small spine. Femora brown, some black spots between posterior veinlets of tegmina, 4 big spines on lower side of fore and mid femora, 6 on hind femora. Ovipositor short (2.5 mm) and crenulated at the tip of lower valve. The ratio length/width of tegmina is 3.3.

Measurements.—Cf. Tables 1 and 2; length of the ovipositor: 2.5 mm.

Diagnosis.—*T. aristophanousi* is characterised by its stridulatory area, stridulatory file (Figs 61, 62) and the subgenital plate, long and with a more or less narrow and deep concavity, cerci are stout basally (Figs 63, 64).

Etymology.—This species is dedicated to Marios Aristophanous, who, together with P. Moretto and E. Ruzzier collected in the Ivory Coast with a light trap many specimens of Orthoptera and made them available to the author.

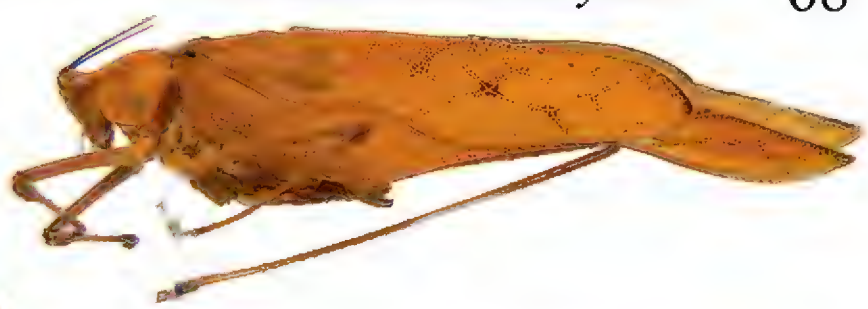
Distribution.—*T. aristophanousi* is known from Ivory Coast and Sierra Leone; it probably covers other intermediate western African countries.

Characters of females of the genus *Tetraconcha* (Figs 79–85)

Females may be separated by the ratio length/width of tegmina, lying between 2.6 and 3.4 in *T. fenestrata*, 3.3 in *T. aristophanousi* sp. n., 3.4 in *T. longipes*, between 4.0 and 4.8 in *T. stichyrata*, 5.0 in *T. morettoi* sp. n., 6.5 in *T. banzyvilliana*. In *T. smaragdina*, according to Bolívar (1906), the ratio length/width tegmina in a female from Cameroon was 2.5, in another 4.5, but since now more new species belonging to the "*smaragdina*-group" were discovered, it is unlikely that the female described by him belongs to *T. smaragdina* or to another new species of the group. In addition, there are 3–4 diagonal

67 *Tetraconcha banzyvilliana*

Tetraconcha stichyrata 68



69 *Tetraconcha fenestrata*

Tetraconcha smaragdina 70

Tetraconcha ruzzieri n. sp.

71

Tetraconcha morettoi n. sp. 72

Tetraconcha perezi n. sp.

73

Tetraconcha loubesi n. sp.

74

Tetraconcha danflousi n. sp.

75

Drepanophyllum marmoratum

76

Debrona cervina

78

Stenamblyphyllum dilutum

77

Figs 67–78. Habitus in lateral view of males of: **67.** *Tetraconcha banzyvilliana*; **68.** *T. stichyrata*; **69.** *T. fenestrata*; **70.** *T. smaragdina*; **71.** *T. ruzzieri* sp. n.; **72.** *T. morettoi* sp. n.; **73.** *T. perezi* sp. n.; **74.** *T. loubesi* sp. n.; **75.** *T. danflousi* sp. n.; **76.** *Drepanophyllum marmoratum*; **77.** *Stenamblyphyllum dilutum*; **78.** *Debrona cervina*.

Tetraconcha banzyvilliana

79

Tetraconcha stichyrata

80

Tetraconcha fenestrata

81

Tetraconcha longipes

82

Tetraconcha aristophanousi n. sp.

83

Tetraconcha cf. *smaragdina*

84

Tetraconcha morettoi n. sp.

85

Drepanophyllum marmoratum

86

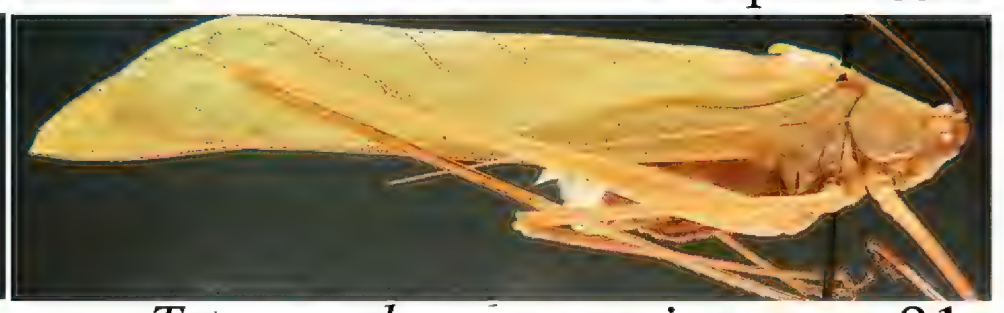
Debrona cervina

87

Figs 79–87. Left habitus in lateral view of females of: **79.** *Tetraconcha banzyvilliana*; **80.** *T. stichyrata*; **81.** *T. fenestrata*; **82.** *T. longipes* holotype female; **83.** *T. aristophanousi* sp. n. paratype; **84.** *T.* cf. *smaragdina*; **85.** *T. morettoi* sp. n. Paratype; **86.** *Drepanophyllum marmoratum*; **87.** *Debrona cervina*.

88 *Tetraconcha smaragdina*

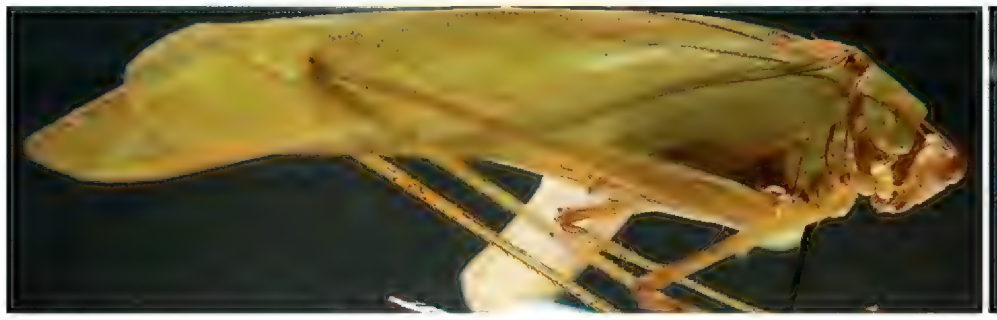
Tetraconcha loubesi n. sp. 89



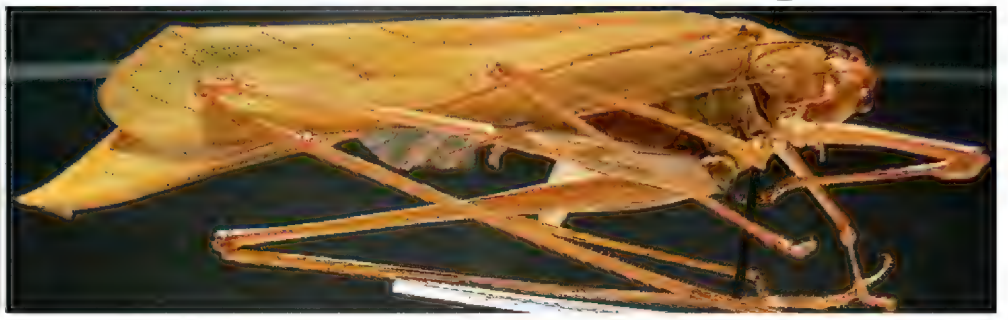
90 *Tetraconcha morettoi* n. sp.

Tetraconcha annoyeri n. sp. 91

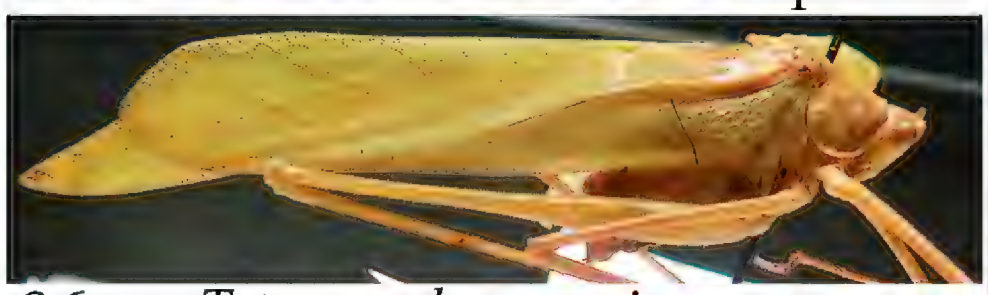
92 *Tetraconcha fijalkowskii* n. sp.



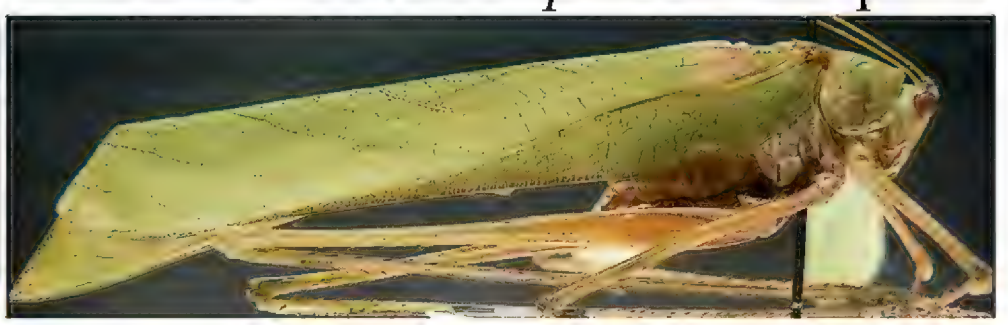
Tetraconcha omonomai n. sp. 93



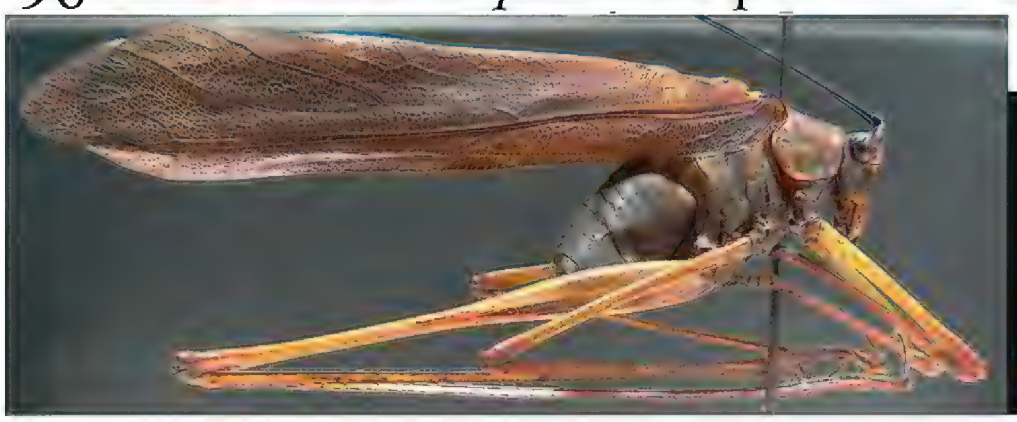
94 *Tetraconcha ndokiensis* n. sp.



Tetraconcha aristophanousi n. sp. 95



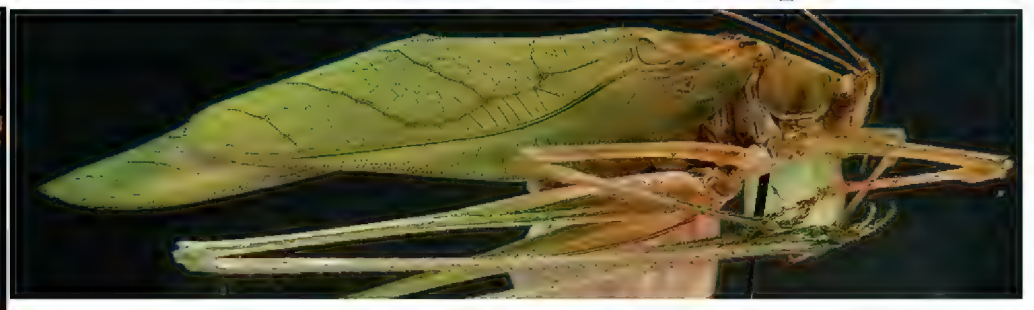
96 *Tetraconcha perezi* n. sp.



Tetraconcha danflousi n. sp. 97

98 *Tetraconcha stichyrata*

Tetraconcha ruzzieri n. sp. 99



Figs 88–99. Right habitus in lateral view of males of: **88.** *Tetraconcha smaragdina*; **89.** *T. loubesi* sp. n.; **90.** *T. morettoi* sp. n.; **91.** *T. annoyeri* sp. n.; **92.** *T. fijalkowskii* sp. n.; **93.** *T. omonomai* sp. n.; **94.** *T. ndokiensis* sp. n.; **95.** *T. aristophanousi* sp. n.; **96.** *T. perezi* sp. n.; **97.** *T. danflousi* sp. n.; **98.** *T. stichyrata*; **99.** *T. ruzzieri* sp. n..

Figs 100–101. 100. Specimen of *T. annoyeri* sp. n. photographed in the field on the litter of the Dzanga-N'Doki National Park. **101.** Canopy of the forest of the Dzanga-N'Doki National Park, where some *Tetraconcha* were collected in 2008-2012 (Photo by P. Annoyer).

veinlets with small brownish spots in *T. fenestrata* and in *T. aristophanousi* sp. n., a net of veinlets with black spots in *T. stichyrata*, a very singular color in *T. banzyvilliana*, while in *T. longipes* the pattern of black spots in the tegmina is very similar to that of *T. stichyrata*.

The genus *Tetraconcha* is known for its high sexual dimorphism. It has not been previously mentioned that males and females differ considerably by the size of the tubercles on the frons (smaller in females) and the larger size of the mandibles in females; e.g. in *T. aristophanousi* sp. n. the maximum width of female mandible is 0.8, while in the male it is 0.4 mm (Fig. 83). Probably, the size of the mandibles depends on the females need to open hard vegetal tissues into which they can insert the very short ovipositor to lay eggs.

The eggs of *Tetraconcha* are similar to those of the genus *Phlaurocentrum* Karsch, 1889 (Massa 2013). In difference to the majority of the other genera, eggs of *Tetraconcha* and *Phlaurocentrum* are not flat, but, even if oval, they are fairly round and thick. The morphology of eggs suggests a high resistance to desiccation (very thick chorionic layers that reduce the rate of water loss). Additionally, the valvules of the ovipositor are not laterally flattened, which indicates that the eggs are not inserted between the layers of the leaf epidermis. This is possibly due to the fact that they lay their eggs in clusters between cracks of tree bark.

Key to males of species of the genus *Tetraconcha* Karsch, 1890 (cf. also Tables 1 and 2).

T. longipes (Bolívar, 1893) is not included, being known only from the female sex)

1 Tegmina with a translucent area (window) near the base..... 2
– Tegmina without a translucent area near the base..... 4
2 Black spot laterally on the metanotum. 3
– Metanotum without black spot, stridulatory area and stridulatory file as in Figs 15 and 16. Central and West Africa.....*T. fenestrata* Karsch, 1890
3 Stridulatory area and stridulatory file as in Figs 11 and 12. Ivory Coast.....*T. ruzzieri* sp. n.
– Stridulatory area as in Fig. 19, cubital area occupied by the window, stridulatory file as in Fig. 20, subgenital plate with a "V"-shaped concavity (Figs 21–22). Ivory Coast.....*T. danflousi* sp. n.
4 Subgenital plate apically pointed, not concave (Fig. 25), hind wings remarkably exceeding tegmina, cubital areas very wide. Stridulatory area and stridulatory file as in Figs 23 and 24. Cameroon, Gabon, Ivory Coast. ..... *T. stichyrata* Karsch, 1890
– Subgenital plate apically more or less concave, hind wings moderately exceeding tegmina, cubital areas less wide..... 5
5 Tegmina brightly bicolored, stridulatory area and stridulatory file as in Figs 26 and 27. Tanzania, Uganda, Central African Republic, Democratic Republic of Congo and Cameroon.....*T. banzyvilliana* Griffini, 1909
– Tegmina uniformly colored, green, yellowish, brown..... 6
6 Tegmina brown with bright yellow stridulatory area (Fig. 28), stridulatory file as in Fig. 29, subgenital plate with a very small concavity (Figs 30–31). Central African Republic (Dzanga-N'Doki National Park). .....*T. perezi* sp. n.
– Tegmina green-yellow or green-brownish, stridulatory area not particularly bright. 7
7 Species green-brownish colored, often with brownish stridulatory area. Yellow or white spots on tegmina absent..... 8
– Species green-yellowish colored, small yellow or whitish spots scattered on tegmina..... 9
8 Black spots on posterior margin of tegmina scarce or absent. Subgenital plate long and apically narrowed with a narrow concavity and two longitudinal carinae on the sides (Figs 35–36). Stridulatory area and stridulatory file as in Figs 32–34. Cameroon, Democratic Republic of Congo, Central African Republic..... .....*T. smaragdina* Brunner von Wattenwyl, 1891
– 7–8 large black spots on veinlets of tegmina. Subgenital plate large and short with a fairly developed concavity (Figs 43–44). Stridulatory area and stridulatory file as in Figs 41 and 42. Central African Republic (Dzanga-N'Doki National Park). .....*T. morettoi* sp. n.
9 Yellowish or whitish spots scattered on tegmina, ventral side of hind femora generally brownish, stridulatory area and stridulatory file as in Figs 49 and 50, subgenital plate as in Figs 51–52. Central African Republic (Dzanga-N'Doki National Park). ..... *T. annoyeri* sp. n.
– Yellow spots scattered on tegmina, ventral side of hind femora not brownish. 10
10 Tegmina mainly green with yellow spots between veinlets. Stridulatory area, stridulatory file and subgenital plate as in Figs 61–64. Ivory Coast and Sierra Leone..... *T. aristophanousi* sp. n.
– Tegmina green-yellowish or green-brownish with yellow spots between veinlets and small black spots on posterior margin. 11

11 Tegmina with many small yellow spots between veinlets, stridulatory area, stridulatory file and subgenital plate as in Figs 53–56. Central African Republic (Dzanga-N'Doki National Park)..... *T. fijalkowskii* sp. n.

– Tegmina with few small yellow spots between veinlets. 12

12 Subgenital plate long with a wide concavity (Figs 59–60), cubital areas of tegmina not well developed (Fig. 57), stridulatory file as in Fig. 58. Central African Republic (Dzanga-N'Doki National Park).... ..... *T. omonomai* sp. n.

– Subgenital plate, stridulatory area and stridulatory file differently shaped. 13

13 Subgenital plate with a deep concavity (Figs 39–40), stridulatory area and stridulatory file as in Figs 37–38. Central African Republic (Dzanga-N'Doki National Park)..... *T. loubesi* sp. n.

– Subgenital plate short with a little concavity (Figs 47–48), stridulatory area and stridulatory file as in Figs 45–46. Central African Republic (Dzanga-N'Doki National Park)..... *T. ndokiensis* sp. n.

Concluding remarks on the evolutionary radiation of Tetraconcha

Tetraconcha species are certainly not an iconic group, like Darwin's finches of the Galápagos or the Cichlids of Lake Victoria (cf. Soulebeau et al. 2015), and their biology is fairly unknown. However, that of *Tetraconcha* is a case of multiple speciation, not in islands or lake systems, but within a tropical forest ecosystem. The emergence of many species from a common ancestor and the phenotypic diversification within the same environment deserve discussion. Evolutionary radiation is comparatively poorly studied in tropical rainforests of Central Africa, because the local biodiversity has been little documented (Soulebeau et al. 2015). However, recent papers on Phaneropterinae of the Dzanga-N'Doki National Park have highlighted the co-occurrence of 8 species of the genus *Catoptropteryx* Karsch, 1890, 7 of *Eurycorypha* Stål, 1873, 8 of *Phlaurocentrum* Karsch, 1889, 3 of *Cestromoecha* Karsch, 1893, 3 of *Dapanera* Karsch, 1889, and 8 of *Arantia* Stål, 1874 (Massa 2013, 2015, 2016, Hemp and Massa 2017). Also other groups of insects have representatives in this protected forest area and species of different orders have the specific name *ndokiensis* or *ndoki* (e.g. Tortorici et al. 2016). This demonstrates directly the high local biodiversity and indirectly the high variety of habitats. Thus, similar groups of insects evolved in similar environments, possibly promoted by similar local factors stimulating adaptation.

Concerning *Tetraconcha*, the increase in morphological disparity and taxonomic diversity in the '*smaragdina* group' is very likely the effect of an evolutionary radiation, which may depend on 'adaptive' changes to micro-habitats within the wide tropical forest environment of central Africa. Seven species here treated were collected with the aid of a lamp in the same site and dates and certainly live close by. They may occupy different ecological niches (possibly different layers of vegetation), but live in the same forest site (Fig. 101) and have the same phenology, co-occurring and being active in January-March. In addition, three further undescribed species live together in the Ivory Coast, and probably a deeper examination of specimens preserved in Natural History Museums will result in the discovery of further undescribed species. One of the morphological characters observed to discriminate the above cited species is the stridulatory system: in these taxa, differences in the shape and number of teeth of stridulatory system result in a different sound, which in most Orthoptera is a very important species-specific barrier (Heller 2006).

Has the emergence of many new species from a common ancestor, occurred in sympatry, accompanied by an ecological and phenotypic diversification? Phenotypic diversity of *Tetraconcha* species was very likely linked to ecological diversity of the African tropical forest, and potential selective pressures might have promoted the speciation through their isolation. The potential selective pressures that could have promoted such strikingly high level of speciation are unknown, and the existence of any adaptation supposedly driving the radiation has not been tested. The necessary test in this case should be to find a pattern of ecomorphological divergence demonstrating that phenotypes and ecology are closely related (cf. Lieberman 2012), but this information is not available. However, African Phaneropterinae lie within a taxonomic group that has a great propensity to speciate.

According to Simões et al. (2016) there are various types of evolutionary radiation. Very probably, the genus *Tetraconcha* has undergone geographic radiation in Central and West Africa (allopatric speciation). Conversely, the case occurred in the Dzanga-N'Doki National Park is more difficult to understand. Tropical forest canopy is known as one of the most diversified environments, holding many ecological niches, where numerous species of insects and other animals adapted and evolved (Malhi et al. 2013). Some of them only live in well-defined layers of vegetation and only by chance that they may be detected during entomological researches (e.g. attracted by light during the night).

Thus, if we consider the ecological differences in the forest canopy of Central Africa, speciation may have occurred in *Tetraconcha* species both by adaptive and exaptive radiation, *sensu* Soulebeau et al. (2015) and Simões et al. (2016). According to Simões et al. (2016), adaptive radiation is the increase in the rate of speciation driven primarily by biotic factors in the form of adaptations associated both with ecological and morphological roles of individuals involved. Conversely, exaptive radiation is the increase in the rate of speciation driven by a previously acquired trait becoming advantageous under a new selective regime. *Tetraconcha* species in the Dzanga-N'Doki National Park evolved traits primarily linked to the sound communication and this very probably occurred when a selective regime was established. Changes in this kind of phenotypic trait through time may have occurred randomly, possibly driven by genetic drift. However, sound traits play an important role in the isolation and evolutionary radiation (Heller 2006); thus, the exaptive, more likely than adaptive radiation, has occurred in the case of the Dzanga-N'Doki *Tetraconcha* species.

Finally, a climatic radiation may have co-occurred, at least for some of the species involved. Tropical forest region of Central and West Africa, also termed Guineo-Congolian region, is the second largest tropical forest of the world, with 89.3% of the total forest surface in Central and 6.0% in West Africa (Malhi et al. 2013). According to Maley (1996) African rainforests retreated during dry periods, with slow-dispersed species, expanding slowly out of refugia. The rapid climate fluctuations after the Ice Age (between 11000 and 4000 years BP) would have favoured the dispersion of species. The climate of tropical Africa following the Ice Age was warmer and wetter than present (African humid period: Willis et al. 2013). The climate in most Central Africa shifted to a drier regime between 4000 and 2000 years BP, when the forest cover retreated (Willis et al. 2013). Climatic radiation is a type of geographic radiation in which allopatric speciation in the region is driven by changes in climate (Simões et al. 2016). Speciation events are often correlated with humid and dry periods; forest expansion during humid periods and retraction during dry periods are considered the best explanation

for the patterns of geographical species distribution found on East African mountains (Schultz et al. 2007, Hemp et al. 2015). Thus, following the above reported reconstruction, we may hypothesize that in the area of Dzanga-N'Doki tropical forest the ancestor of '*smaragdina*-group' could have remained isolated in patches of forest during a dry period and derived populations could have met each other when the climate shifted to a warmer regime (African humid period). They could have undergone multiple episodes of allopatric speciation, more probably than of sympatric radiation (Lieberman 2012). Bioacoustic differences allowed them to remain separated.

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